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SHELTER UPGRADING MANUAL: HOST AREA SHELTERS.(U)
MAR 80 C WILTON, B L GABRIELSEN, R S TANSLEY DCPA01-78-C-0215
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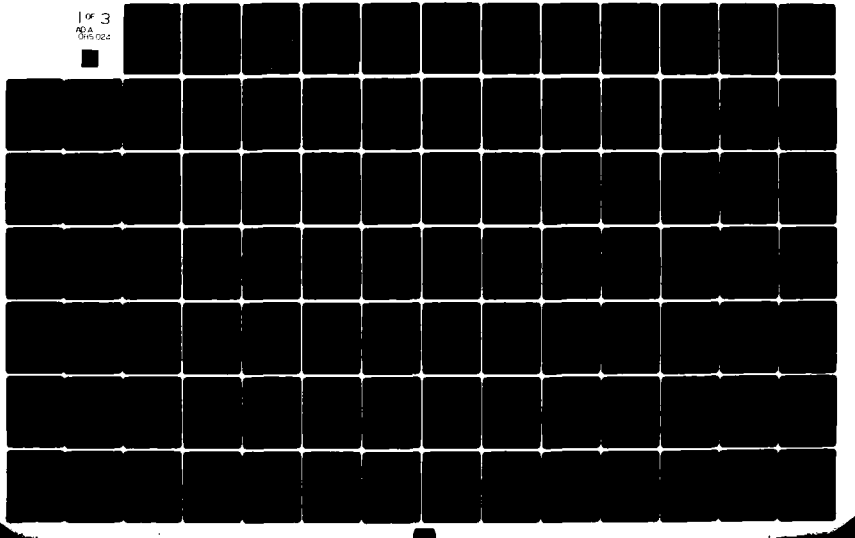

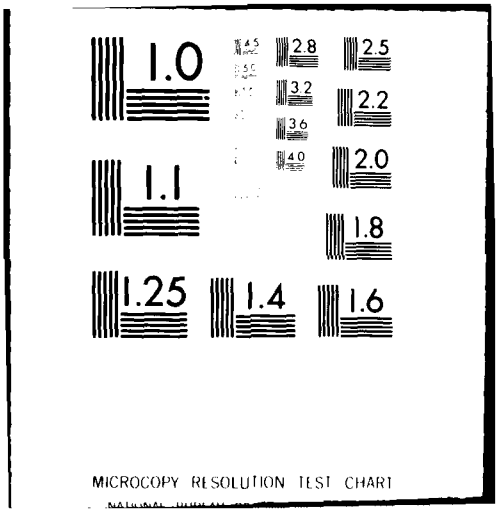
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March 1980

shelter upgrading manual: host area shelters

FINAL REPORT

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The manual is one of a series being developed in support of the civil defense concept of crisis relocation planning. One basic element of crisis relocation is shelter protection of the people in the relocated environment, and without adequate shelter, crisis relocation planning is not viable.

This manual is designed to be used by planners in host areas. It presents a methodology for evaluating floors, roofs, and openings;

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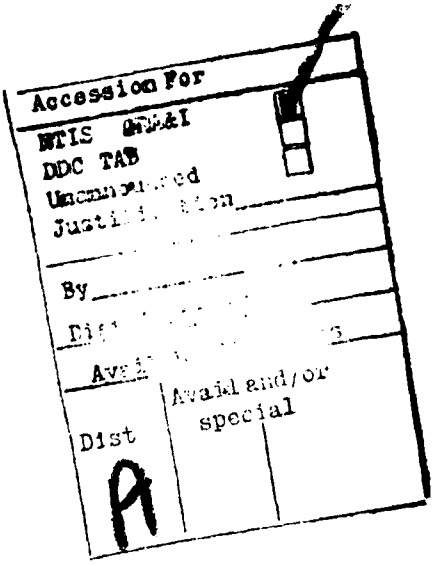
develops a variety of ways to provide the necessary structural upgrading for blast and fallout protection; develops a framework for the practical use of the manual by all persons of interest; and contains charts, pictorial representations, and worksheets that complement and simplify the utility of the manual.

The information contained herein is supported by a test program, DCPA01-79-C-0231, Work Unit 1127G, and previously developed structural information.

The manual is in looseleaf form to permit removal of pertinent worksheets and charts for developing upgrading plans for a specific building, and to permit the addition of new and replacement material as the work progresses.



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SHELTER UPGRADING MANUAL: HOST AREA SHELTERS

by

C. Wilton, B.L. Gabrielsen, R.S. Tansley

for

Federal Emergency Management Agency
Washington, D.C. 20472

Contract No. DCPA01-78-C-0215, Work Unit 1127H
Dr. Michael A. Pachuta, COTR

FEMA REVIEW NOTICE:

This report has been reviewed in the Federal Emergency Management Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Federal Emergency Management Agency.

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This manual is one of a series being developed in support of the civil defense concept of crisis relocation planning. One basic element of crisis relocation is shelter protection of the people in the relocated environment, for without adequate shelter, crisis relocation planning is not viable.

This manual is designed to be used by planners in host areas. It presents a methodology for evaluating floors, roofs, and openings; develops a variety of ways to provide the necessary structural upgrading for blast and fallout protection; and develops a framework for the practical use of the manual by all persons of interest. The information contained herein is supported by a test program, under Contract No. DCPA01-79-C-0231, Work Unit 1127G, and previously developed structural information.

Sections of the manual assist in the selection and identification of potential shelter facilities, explain the use of the manual and the selection of upgrading methods, contain charts on the upgrading of various floor and roof systems, and present sketches of the upgrading methods and the resources required for each method. Worksheets and the necessary charts for sizing the shoring or other materials required for each method complement and simplify the utility of the manual. Also included are appendices that assist in the evaluation of a structure for use as a potential shelter, show data and charts for closing small openings, and illustrate alternative types of shoring systems.

The manual is in a looseleaf format so that worksheets and data sheets can be removed to develop upgrading plans for a specific structure. This format will also allow for the insertion of new data and sections as they become available.

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Table of Contents

Glossary and List of Notations

As built —
Structure prior to upgrading

Host area —
Area that is subjected to blast pressures of 2 psi or less

Key worker area —
Area that is subjected to blast pressures greater than 30 psi

Overpressure —
Pressure caused by blast

Protection factor —
Factor that compares degree of radiation protection to zero protection

Protection factor key —
Earth thickness in feet required to obtain specified radiation protection

Risk area —
Area that is subjected to blast pressures from 2 psi to 30 psi

Shelter rating —
Rating given a shelter, in roman numerals, corresponding to a given overpressure (see Fig. 1-1)

Survival rating —
95% probability of survival for a structure of a given shelter rating

psf	pounds per square foot
psi	pounds per square inch
kPa	kilopascal (psi times 6.895)
S_R	survival rating
P_f	protection factor
I	shelter rating - 40 psi overpressure
II	shelter rating - 30 psi overpressure
III	shelter rating - 20 psi overpressure
IV	shelter rating - 10 psi overpressure
V	shelter rating - 5 psi overpressure
VI	shelter rating - 2 psi overpressure
VI^+	slightly better than a VI shelter rating (used for all shelter ratings)
VI^-	slightly less than a VI shelter rating (used for all shelter ratings)
N	no additional radiation protection required
"0"	provides no blast survival
†	depth of earth required for radiation protection would cause collapse

SECTION 1

INTRODUCTION

Section 1
INTRODUCTION

This manual is intended for use in the identification of and the upgrading, if required, of shelter spaces to support Crisis Relocation Planning. Concern is limited here to shelters in the "host" areas, where it is assumed blast overpressures do not exceed 2 psi and radiation protection equivalent to 18 in. of earth is adequate.

The manual is organized as follows: Section 2 will assist in the selection and identification of potential shelter facilities. Section 3 explains the use of the manual and the selection of methods for upgrading with examples. Sections 4 and 5 contain the key charts on the upgrading of various floors and roofs. Section 6 contains sketches of the various upgrading methods and the resources required for each. Section 7 has the various worksheets for each method. Section 8 includes the charts necessary for sizing the shoring required for the upgrading method selected. At the end of the manual, appendices containing supplemental information are provided. Appendix A assists in the evaluation of a structure for use as a potential shelter. Appendix B provides data and charts for closing small openings. Appendix C illustrates alternative types of shoring systems.

The manual is in looseleaf format for two reasons: (1) Use of the manual requires that worksheets and data sheets be removed to develop upgrading plans for a specific building; and (2) In its present form the manual is far from complete, and replacement or new pages and sections, which are being developed by SSI, will be supplied for insertion when available. Included in this new information will be additional upgrading schemes for floors and roofs, based on upcoming full-scale tests of floor and roof systems;

procedures for upgrading walls of aboveground shelters; a more extensive closure section; and the necessary information for calculating required supplemental equipment such as ventilation, water and sanitation kits.

It should also be noted that the manual is one of a series that will also consider key worker and risk area shelters. In these other manuals higher overpressures will be considered, and shelters will be ranked by survival ratings "as built" and for the various upgrading schemes. Shelters will be rated for selected overpressures, and each shelter rating will carry a roman numeral designation corresponding to a particular overpressure. A pictorial representation of the relationship between shelter rating, overpressure, and the key worker, risk, and host areas is shown in Fig. 1-1. As mentioned above, this manual confines itself to VI shelter rating or a maximum of 2 psi overpressure, which is defined as a host area shelter.

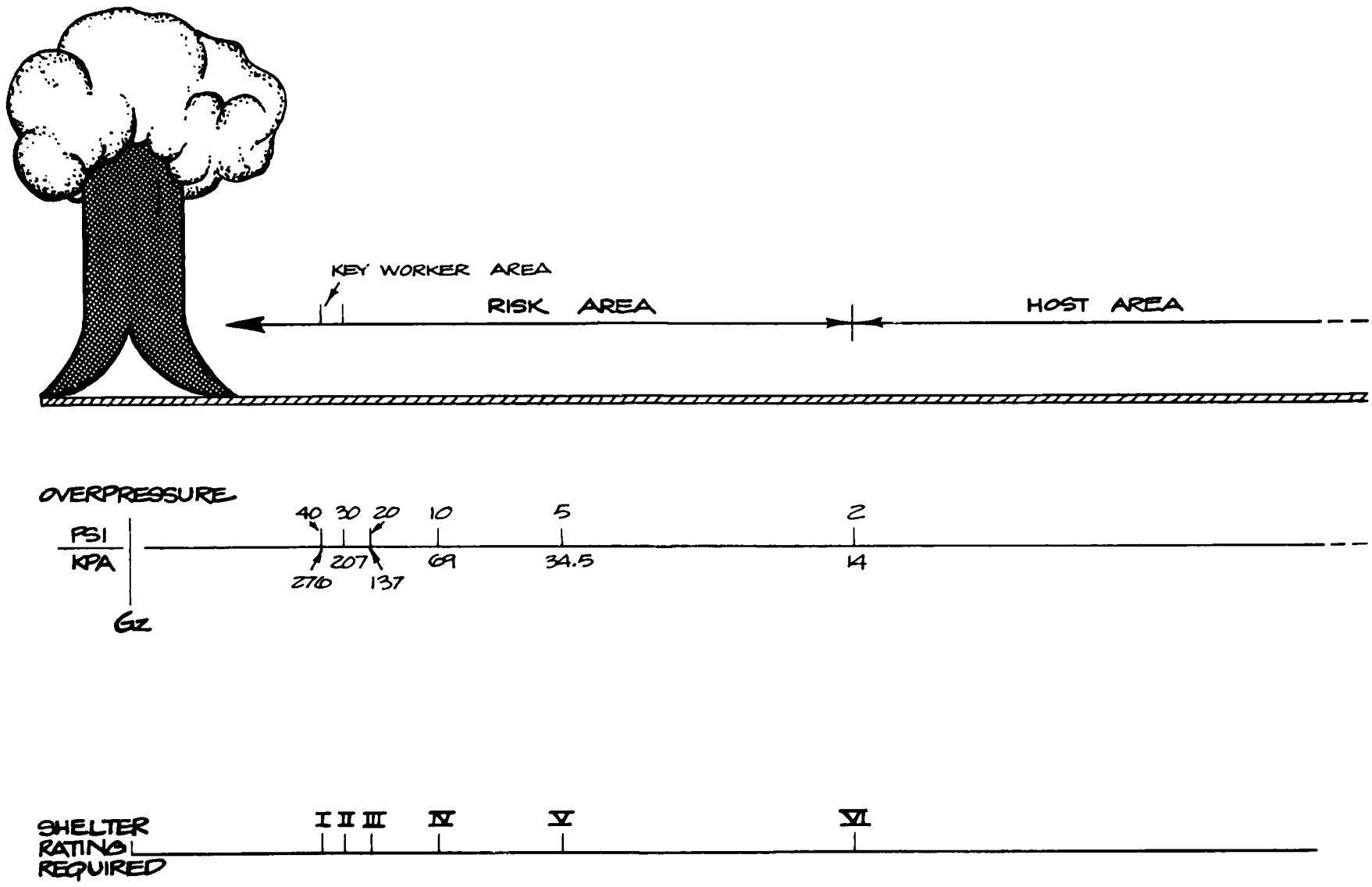


Fig. 1-1. Comparison of Overpressure and Shelter Rating Required.

SECTION 2

SELECTION AND IDENTIFICATION OF POTENTIAL SHELTER FACILITIES

Section 2

SELECTION AND IDENTIFICATION OF POTENTIAL SHELTER FACILITIES

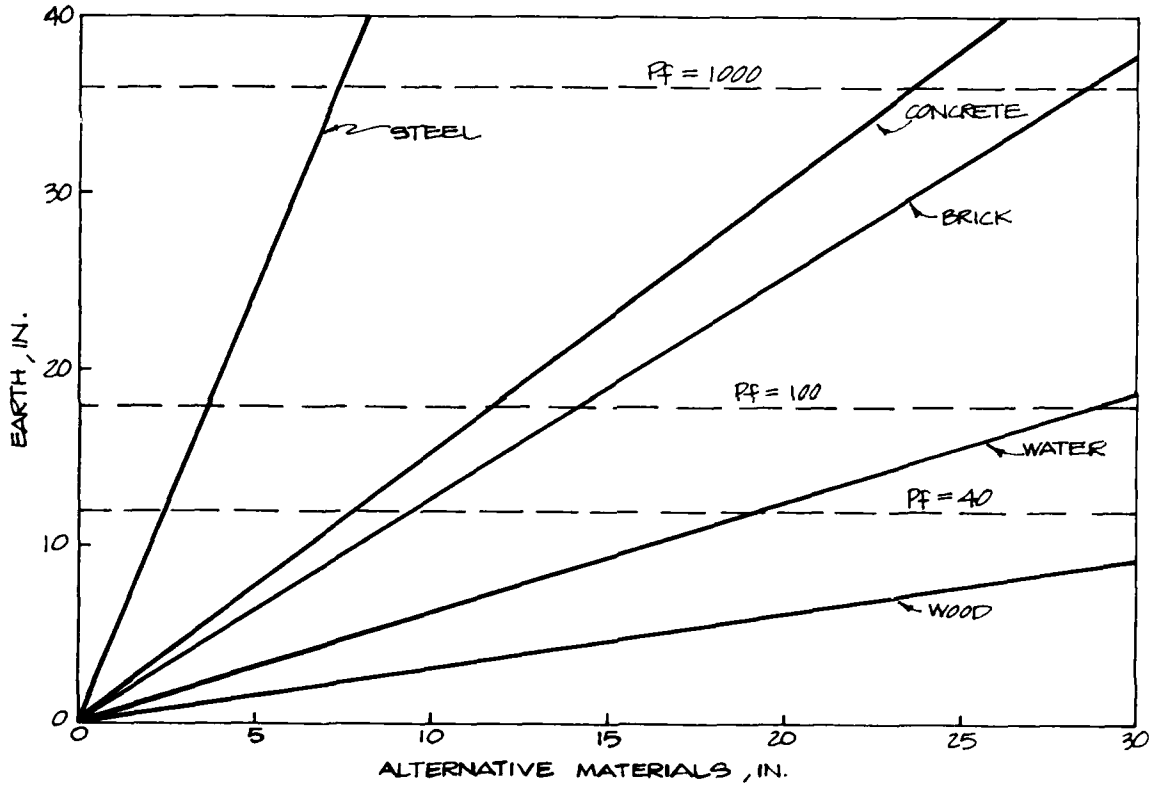
INTRODUCTION

The objective of this section of the manual is to describe a simple method for evaluation and selection of the potential shelter facility; i.e., building or portion thereof. The charts used in this manual have been simplified and are conservative. By conservative it is meant that 95% of the building elements are better than the rating provided; conversely, it has been assumed that a 5% probability of collapse is an acceptable risk level.

The initial evaluation and selection process is based on "intended use" code-based design criteria. With few exceptions, most buildings constructed during the past 50 years were designed using some type of building code, either national or local codes, which are usually adaptations of the national codes. These codes specify the minimum design standard for each of the building elements; i.e., floors, walls, and roofs. See Appendix A for assistance in the evaluation of potential shelter facilities.

Since a host area shelter will probably only be exposed to a blast overpressure of 1 or 2 psi, a variety of aboveground as well as basement shelters can be used. Also a host area, or VI rated, shelter needs to be strong enough to support the necessary fallout protection. This has led to the use of both a protection factor (P_f) rating and a survival (S_R) rating for each of the structural components and upgrading techniques used in this manual. The protection factor key relates to fallout radiation protection factors of 40, 100, and 1000, and indicates the depth of earth in feet, or equivalent, required to achieve that particular radiation factor. "N" indicates that no additional radiation protection is required since the mass of the structural element is adequate protection for the P_f listed.

The equivalent radiation protection of 1, 1.5, and 3 ft of earth (assumed weight = 100 pcf) may be achieved by use of alternative materials. The chart below indicates the relationship in inches between five common materials and earth. For example, 12 in. of earth is equal in radiation protection to 8 in. of concrete, 2½ in. of steel, etc.



FLOOR SYSTEM ANALYSIS

The design criteria for floors are specified as the recommended minimum floor live loads as a function of the original intended use of the structure. A table of minimum floor loads is shown in Table 2-1. Thus, if the original intended use and the type of construction (i.e., wood, steel, or concrete) are known, it is possible to establish collapse loads for the floor system. This is demonstrated in Table 2-2, which gives the collapse load for light, medium, and heavy design floors for the four most common types of construction — wood, light steel, heavy steel, and concrete. These data can then be used to derive the "as built" floor Safety Rating table shown in Table 2-3. This table indicates whether or not the "as built" floor is strong enough to sustain a 2 psi blast with 18 inches of soil (P_f = 100) for radiation protection, or a Survival Rating of VI. If the floor will not meet the criteria of an S_R = VI, as built, upgrading is required. Section 3 should be consulted for assistance in the selection of upgrading schemes. As an example, note that wood constructions, light and medium, will <u>not</u> support the required blast load plus the radiation protection as built, and will require upgrading. Heavy wood construction is "OK" as built.

Halls and corridors are usually designed to support a live load equal to the occupancy loading that they serve, with some minor exceptions as shown in Table 2-1, and therefore, may be upgraded as a floor. The walls of halls and corridors should be carfeully evaluated to assure that they are, in fact, bearing walls and that the short span encountered between the walls is actually the span to be considered in the upgrading determination. In many cases, only one of the walls is a bearing wall, and the span across the corridor is an extension of the span of the adjacent room, with a non-load-bearing partition separating the corridor from the room. In this case, the room and corridor spans would be added together to determine the length of the span to be considered.

Table 2-1

DESIGN INFORMATION: RECOMMENDED MINIMUM FLOOR LIVE LOADS

UNIFORMLY DISTRIBUTED LOADS

Occupancy or Use	Live Load (psf)
Apartments (see Residential)	
Armories and drill rooms	150
Assembly halls and other places of assembly:	
Fixed seats	60
Movable seats	100
Platforms (assembly)	100
Bowling alleys, poolrooms, and similar recreational areas	75
Corridors:	
First floor	100
Other floors, same as occupancy served except as indicated	
Dance halls and ballrooms	100
Dining rooms and restaurants	100
Dwellings (see Residential)	
Garages (passenger cars only)	50
Grandstands (see Reviewing stands)	
Gymnasiums, main floors and balconies	100
Hospitals:	
Operating rooms, laboratories	60
Private rooms	40
Wards	40
Corridors, above first floor	80
Hotels (see Residential)	
Libraries:	
Reading rooms	60
Stack rooms (books & shelving at 65 pcf) but not less than	150
Corridors, above first floor	80
Manufacturing:	
Light	125
Heavy	250

UNIFORMLY DISTRIBUTED LOADS

Occupancy or Use	Live Load (psf)
Office buildings:	
Offices	50
Lobbies	100
Corridors, above first floor	80
File and computer rooms require heavier loads based upon anticipated occupancy	
Penal institutions:	
Cell blocks	40
Corridors	100
Residential:	
Multifamily houses:	
Private apartments	40
Public rooms	100
Corridors	80
Dwellings:	
First floor	40
Second floor and habitable attics	30
Uninhabitable attics	20
Hotels:	
Guest rooms	40
Public rooms	100
Corridors serving public rooms	100
Corridors	80
Reviewing stands and bleachers	100
Schools:	
Classrooms	40
Corridors	80
Sidewalks, vehicular driveways, and yards, subject to trucking	250
Skating rinks	100
Stairs and exitways	100
Storage warehouse:	
Light	125
Heavy	250

UNIFORMLY DISTRIBUTED LOADS

Occupancy or Use	Live Load (psf)
Stores:	
Retail:	
First floor, rooms	100
Upper floors	75
Wholesale	125
Theaters:	
Aisles, corridors, and lobbies	100
Orchestra floors	60
Balconies	60
Stage floors	150
Yards and terraces, pedestrians	100

DESIGN LOAD GROUPS

(as used in this manual)

LIGHT:

40 to 60 psf

MEDIUM:

80 to 125 psf

HEAVY:

150 to 250 psf

Table 2-2

FLOOR SYSTEM COLLAPSE LOADS[1] psf (psi)

Floor Type and Dead Load (D.L.) \ Live Load	LIGHT (L) 50 psf (40 - 60 psf)	MEDIUM (M) 100 psf (80 - 125 psf)	HEAVY (H) 200 psf (150 - 250 psf)
Wood (W) Construction (D.L. = 20 psf)	120 (0.8) soil[2] 200 (1.4) blast[3]	220 (1.5) soil[2] 367 (2.6) blast[3]	420 (2.9) soil[2] 700 (4.9) blast[3]
Steel, Light (SL) Construction (D.L. = 30)	105 (0.7)	190 (1.3)	does not exist
Steel, Heavy (SH) Construction (D.L. = 80)	140 (1.0)	225 (1.6)	395 (2.8)
Concrete (C) Construction (D.L. = 100)	200 (1.4)	300 (2.1)	500 (3.5)

Notes

(1) Safety factors are 2.0, 1.7, and 2.0 for timber, steel, and concrete, respectively. The 1.7 for steel assumes a truss support system.

(2) Static load (soil)

(3) Dynamic load (blast)

Table 2-3

FLOOR SAFETY RATING TABLE FOR AS BUILT CONSTRUCTIONS

WITH P_f = 100 (18 in. soil) AND S_R = VI (2 psi)

Type \ Loading	Light 50 psf (40 - 60 psf)	Medium 100 psf (80 - 125 psf)	Heavy 200 psf (150 - 250 psf)
Wood Construction	Upgrading required, see Section 3	Upgrading required, see Section 3	"OK" as built
Steel Light Construction	Upgrading required, see Section 3	Upgrading required, see Section 3	Does not exist
Steel Heavy Construction	Upgrading required, see Section 3	Upgrading required, see Section 3	"OK" as built
Concrete Construction	Upgrading required, see Section 3	Upgrading required, see Section 3	"OK" as built

ROOF SYSTEM ANALYSIS

A similar analysis can be applied to roof systems. It is assumed that the roof systems of interest are relatively flat and that the radiation upgrading can be accomplished by adding soil. Table 2-4 provides the results of the analysis in force units.

There are no roof systems that, without upgrading, will have an S_R = VI (2 psi plus 18 in. soil). Refer directly to Section 3 of the manual for the appropriate methods of upgrading.

Table 2-4

ROOF SYSTEM ANALYSIS

Column 1	Column 2	Column 3	Column 4	Column 5
Roof Type	Design Live Load	Design Dead Load	Design Safety Factor	Collapse[4] Load [5]
	psf	psf	psf	psf (psi)
Wood (W)	15	15	2.0	45 (0.3) soil 75 (0.5) blast
Steel[1] (SL) Light Construction	15	25	1.7[3]	45 (0.3) soil or blast
Steel [2] (SH) Heavy Construction	15	60	1.7[3]	65 (0.4) soil or blast
Concrete (C)	15	80	2.0	110 (0.8) soil or blast

Notes

(1) Light steel construction assumes a steel support structure and a timber sheathing system.

(2) Heavy steel construction assumes a steel support structure, steel decking and a lightweight concrete topping.

(3) The 1.7 safety factor assumes truss supports. Beams will provide a higher safety factor.

(4) The collapse load values shown in Column 5 can be increased in snow regions by multiplying the regional design snow load minus 15 psf by the safety factor and adding to Column 5.

(5) If a roof structure is used for parking or some other activity, analyze it as a floor system.

WALL SYSTEM ANALYSIS

Wall systems can also be analyzed in a similar manner. The majority of wall systems can be grouped into three basic categories, as shown in Table 2-5. With regard to blast loading, the design criterion of interest is wind load, which is typically 20 psf. Taking into account the common safety factor of 2, the minimum collapse load for wall systems is 40 psf, or 0.3 psi, as shown in Table 2-6.

Observe that only the most massive walls offer any radiation protection, and only certain ones of those (masonry, brick and concrete infill) provide very minor blast protection. In addition, of course, all window and door openings must have closures added, except as required for ventilation. See Appendix B for methods of closing small openings.

Table 2-5

WALL SYSTEMS

Light (weight: 10 to 25 psf)

- Timber stud (stucco, plywood, etc.)
- Tile (clay)
- Metal stud
- Glass (steel or aluminum frame)
- Steel or aluminum panels
- Plastic (fiberglass/foam)
- Asbestos cement

Medium (weight: 25 to 80 psf)

- Concrete block (non or partially grouted)
- 8-inch brick walls
- 4-inch brick
- 4-inch brick plus 4-inch block or stud

Heavy (weight: greater than 80 psf)

- Stone
- 8-inch concrete block/brick face
- 12-inch brick
- 8-inch concrete

Table 2-6

WALL SYSTEM COLLAPSE LOADS psf (psi)

Wall Type	Design Load	Safety Factor	Collapse Load
Light	20	2.0	40 (0.3)
Medium	20	2.0	40 (0.3)
Heavy	20	2.0	40 (0.3) (1)

Note

(1) When the 12-in. brick and/or 8-in. concrete are built into (infilled) a heavy concrete frame building, this number is 150 psf or 1 psi.

SECTION 3

SELECTION AND IMPLEMENTATION OF UPGRADING SCHEMES

Section 3

SELECTION AND IMPLEMENTATION OF UPGRADING SCHEMES

INTRODUCTION

This section will describe the use of the following sections of the manual in the selection and implementation of an upgrading scheme for the shelter facility selected and identified under Section 2. Included with a description of each of the subsequent sections are examples in the use of the charts, worksheets, illustrations and resource lists.

DESCRIPTION OF SECTION CONTENTS

Sections 4 and 5 are entitled Floors and Roofs, respectively. Each of these sections contains illustrations of typical floor and roof systems in "as built" configurations; that is, as they would appear prior to upgrading. Each of the illustrations has a short paragraph adjacent to it with information on use, spans, and design loading, which further helps the user to identify the system. Additionally, each system has a small inset chart that lists the radiation P_f (protection factor) and key (feet of earth consistent with the protection factor) and the S_R (survival rating) for the particular system "as built." Facing each of the "as built" illustrations is a chart listing the shoring systems applicable to that particular type of construction. This chart also indicates the upgraded Key and S_R for each upgrading scheme, and directs the user to the appropriate illustration of the selected scheme, the charts required for determination of the shoring size and spacing, and the particular worksheet to be used for implementation of the upgrading scheme.

Section 6 contains the illustrations of all the various upgrading schemes and provides a checklist of resources required for each, and Section 7 contains the worksheets for each scheme. Section 8 contains the required charts for shore size and spacing.

EXAMPLE OF MANUAL USE

The user, after reading Section 2 and referring to Appendix A if necessary, has selected a residential basement for a shelter. He observes that the construction type is timber joist and, since the structure was originally built as a residence, he can reasonably assume that the design floor load is "light," as defined in Table 2-1. With this information, the user proceeds to Section 4 and refers to the index in front of the section. Under "Wood Construction — Floor, Timber Joist — light design" he is referred to page 4-1, which contains a sketch of a timber joist floor, some descriptive information, and the survival ratings (S_R) of the "as built" floor with various degrees of radiation protection (P_f). The sketch and description are similar to the intended shelter, but indicate that a radiation protection factor (P_f) of 40 (one foot of earth) would reduce the blast protection, or survival rating (S_R), to "0", and a P_f = 100 (1.5 ft of earth) would cause collapse (+). It is apparent, therefore, that if this selected structure is to be used as a shelter, it requires upgrading.

Facing the page containing the "as built" sketch is a chart listing the various types of upgrading schemes that may be applied to this type of construction. A review of this chart indicates that all these schemes will support significant radiation protection, P_f = 100 with 2 psi blast protection, S_R = VI. An upgrading system should be selected from this list. It is suggested that the illustrations, details, and required resources of each scheme be reviewed prior to making a selection. (If the amount of open floor area is a consideration, several schemes, such as King Post Truss, Flange, and Boxed Beam upgrading, are better suited to maximizing open floor area.) For this example, assume that the user has selected a wood stud wall at midspan as an upgrading scheme. He should then remove the indicated illustration and detail page along with the facing resource list from Section 6, the worksheet from Section 7, and the chart from Section 8. In this case he would remove from the manual: page 6-1, Section 6 (and facing page); page 7-1, Section 7; and page 8-1, Section 8.

An example of the completed worksheet is shown in Fig. 3-1, and the chart used is shown on Fig. 3-2. The timber required — in this case, 324 linear feet of 2 x 4's — should be entered on the resource list. The resources checklist should be consulted for the additional resources required: bracing, hammer, nails, etc.

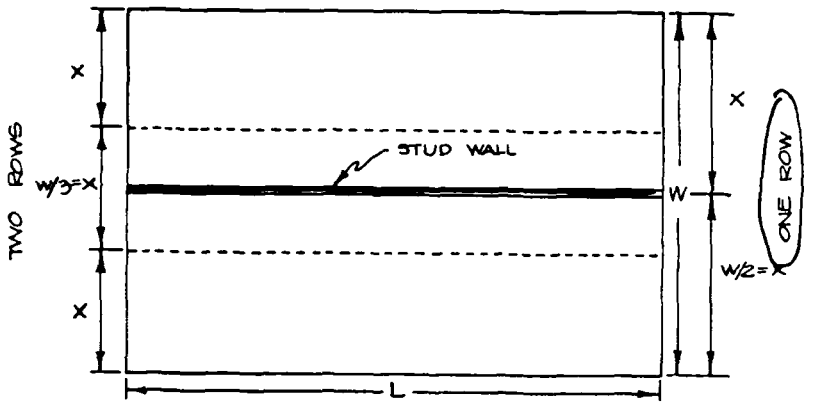
In this example, let us assume that the full basement is actually 36 ft x 24 ft and that the joists are supported at mid-width of the basement by a light steel beam, which is in turn supported by a steel pipe column, at mid-length. This is the condition outlined in Item No. 6 on Worksheet A, and requires the use of Worksheet G, page 7-7, Section 7, to determine post shores required for the steel beam.

Fig. 3-3 shows Worksheet G completed, and Fig. 3-4 shows the chart used with this worksheet. The quantity of posts required should be listed on the resource sheet.

It should be remembered that the quantity of wood studs should be doubled if both sides of the basement are to be upgraded. However, if only one side is to be upgraded, it is still necessary to shore the steel beam at mid-length, as shown in Fig. 3-3.

Appendix B gives assistance on closing small openings (doors, windows, ventilators, etc.) and Appendix C suggests some alternative types of commercial shores, which, if available, might be used.

WORKSHEET A stud wall upgrading



L 36' W 12' H 8'

1. Measure the intended shelter area. Fill in the length (L), width (W), and height (H) of the area in the spaces provided above. These dimensions need not be exact - the length and width to the nearest foot and the height to the nearest 6 in. is sufficient.

2. Sketch in the figure above the intended location of the stud wall(s). If one wall is used, it should be located at midspan along dashed line (W/2) and if two are used, at 1/3 span (W/3) along dotted lines. The wall (s) should be continuous the full length (L) of the area.

3. Determine the distance (X) from the stud wall to the adjacent support (wall, beam, other stud wall, etc.).

   X = 6 ft

4. With (X) and (H) from above, go to Chart A, page 8-1, Section 8, to determine the timber size required; enter Chart A from left with (X) and read over to ceiling height (H). Read above intersection point to find the size of studs and spacing that may be used.

   Stud Size 2 in. by 4 in.
   at 16 in. on center.

5. Timber Requirements: With the above information, a rough estimate may be made of the timber required for the upgrading.

   Studs 2 in. by 4 in.

   $$\frac{H\ 8 \text{ ft} \times L\ 36 \text{ ft} \times 12}{16 \text{ in. on center}} = 216 \text{ lin. ft}$$

   Top Plates (same size as studs, two required)

   L 36 ft x 2 = 72 lin. ft

   Bottom Plate (same size as studs, one required)

   L 36 ft x 1 = 36 lin. ft

   Total Timber Required = 324 lin. ft

   Note: If two walls are used, double the above timber requirement. Enter size and linear feet of timber required on the Resources List.

6. If existing ceiling support(s) are beams in lieu of bearing walls, additional shoring should be provided. Use Worksheet G, page 7-7, Section 7 - Beam Shoring, to determine post shores required.

FIG. 3-1

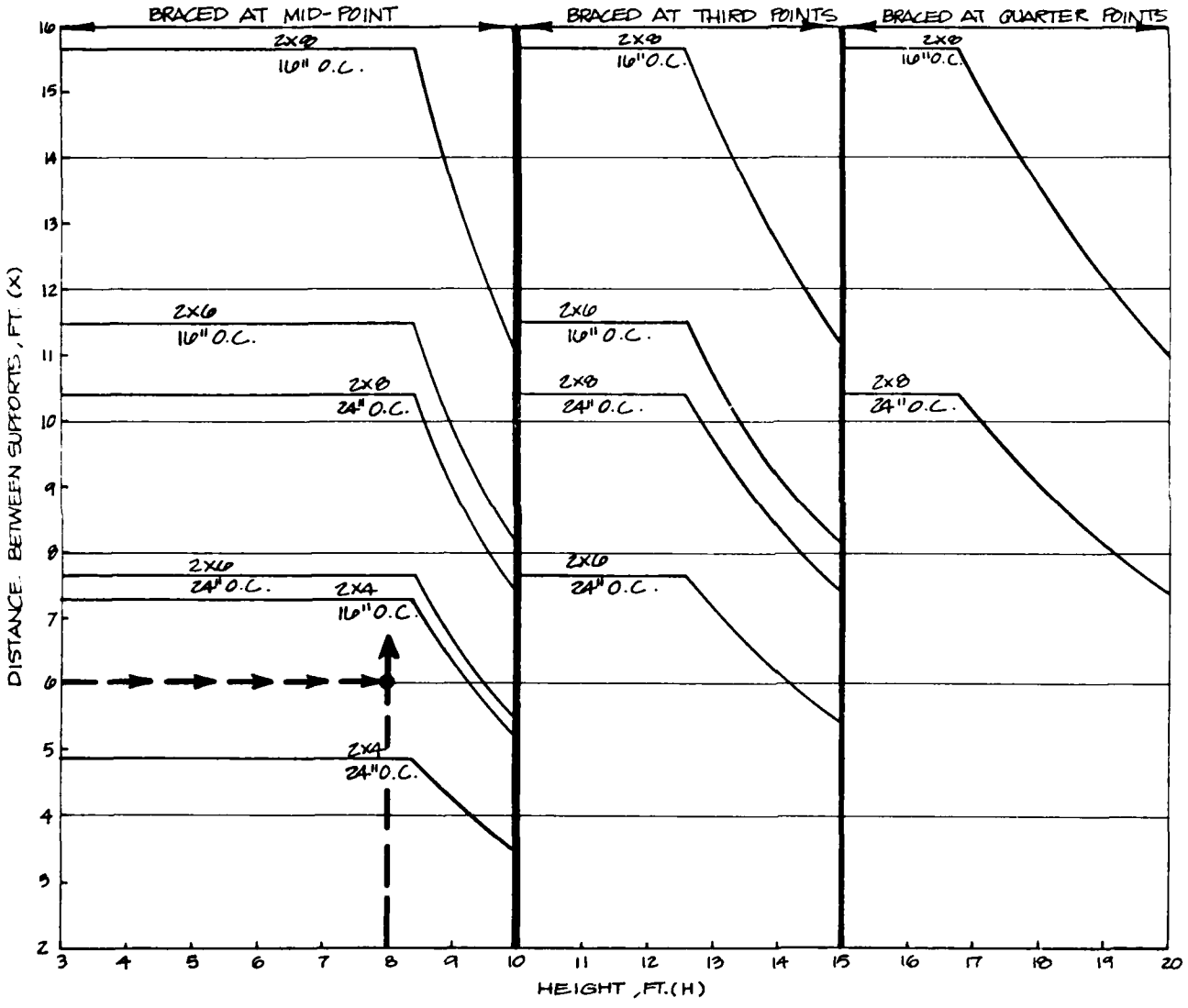
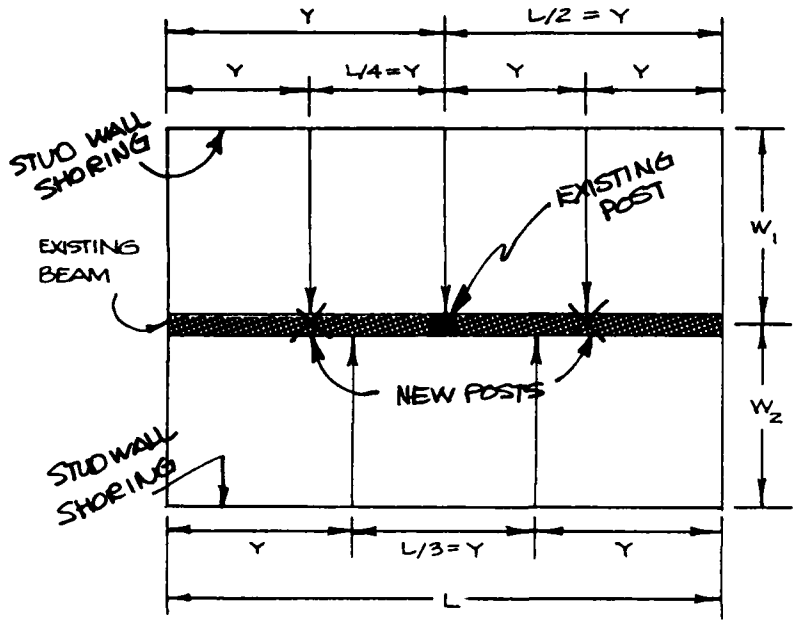


FIG. 3-2

STUD WALL DATA

A

WORKSHEET G beam shoring



L 36' W1 6' H 8'

W2 6'

1. This Worksheet is to be used when the existing ceiling support(s) are beams in lieu of bearing walls. These beams require upgrading with timber posts.

2. Measure the intended shelter area. Fill in the length (L), widths (W_1 and W_2), and height (H) of the area in the spaces provided above. These dimensions need not be exact – the length and width to the nearest foot and the height to the nearest 6 in. is sufficient.

3. Sketch in the figure above the intended location of the posts along the existing beam. They should be located symmetrically at L/2, L/3, or L/4.

4. Determine the distance between the posts (Y). $36/4 = 9$

Y = 9 ft

Calculate (X).

$$\frac{W_1 + W_2}{2} = X = 6 \text{ ft}$$

Multiply X x Y 9x6=54 sq ft supported area

5. With the supported area and (H) from above, go to either Chart B, page 8-2, or Chart D, page 8-4, Section 8, to determine the timber post size required. Use Chart B if the post is supporting a timber beam and Chart D if the post is supporting a beam other than timber (steel, concrete, etc.). Enter the appropriate chart from the left with the supported area and read over to ceiling height. Read above the intersection point to find the size of timber posts that may be used.

Post Size 4 in. by 6 in.

6. Timber Requirements: With the above information, a rough estimate may be made of the timber required for the upgrading.

Post 4 in. by 6 in.

No. of Posts 2 x H 8 ft = 16 lin. ft

Enter size and linear feet of timber required on Resources List.

FIG. 3-3

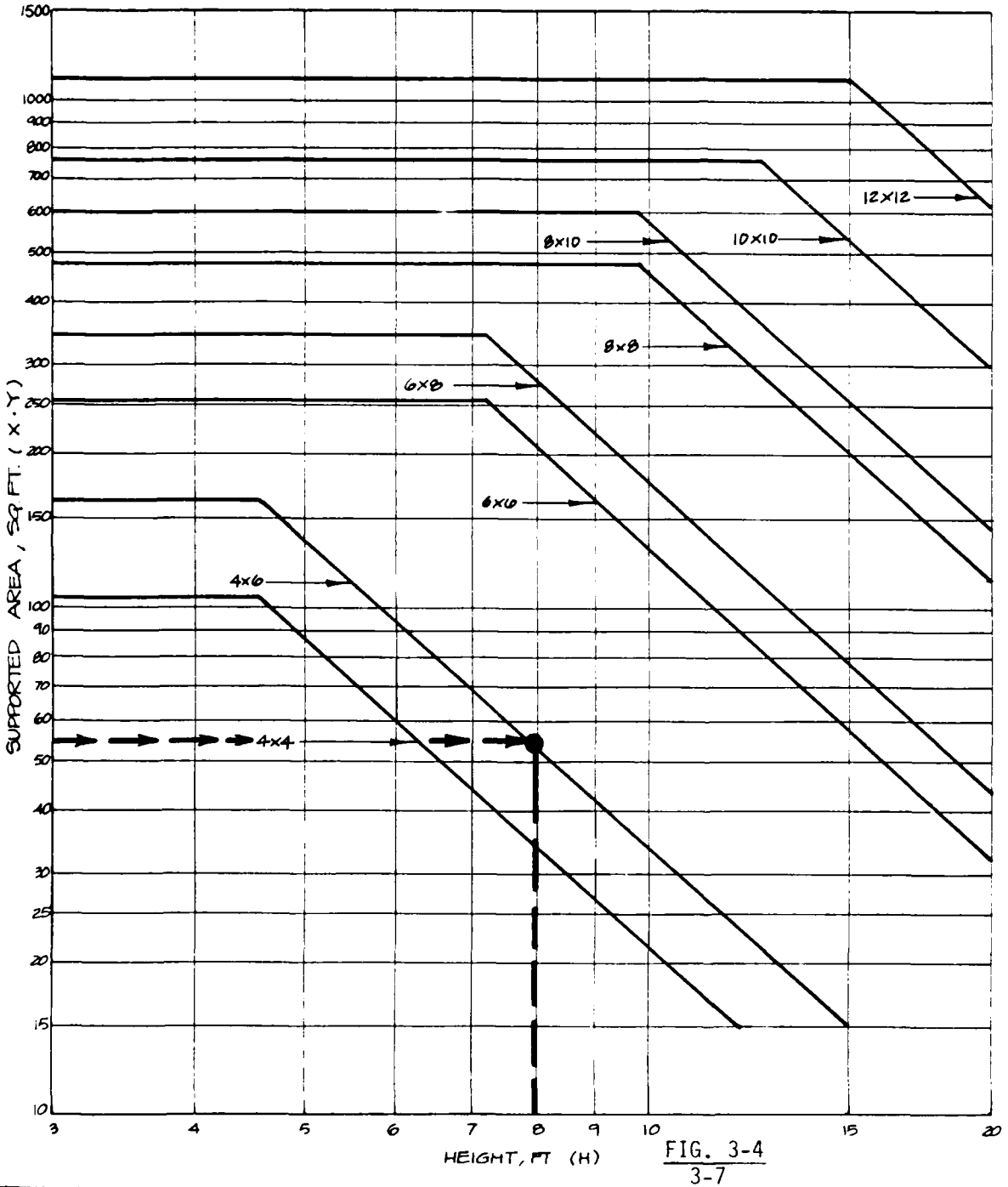


FIG. 3-4

NOTE:

USE THIS CHART WHEN SUPPORTING BEAM OTHER THAN TIMBER (STEEL, CONCRETE, ETC.)

TIMBER POST DATA

D

SECTION 4

FLOORS

INDEX

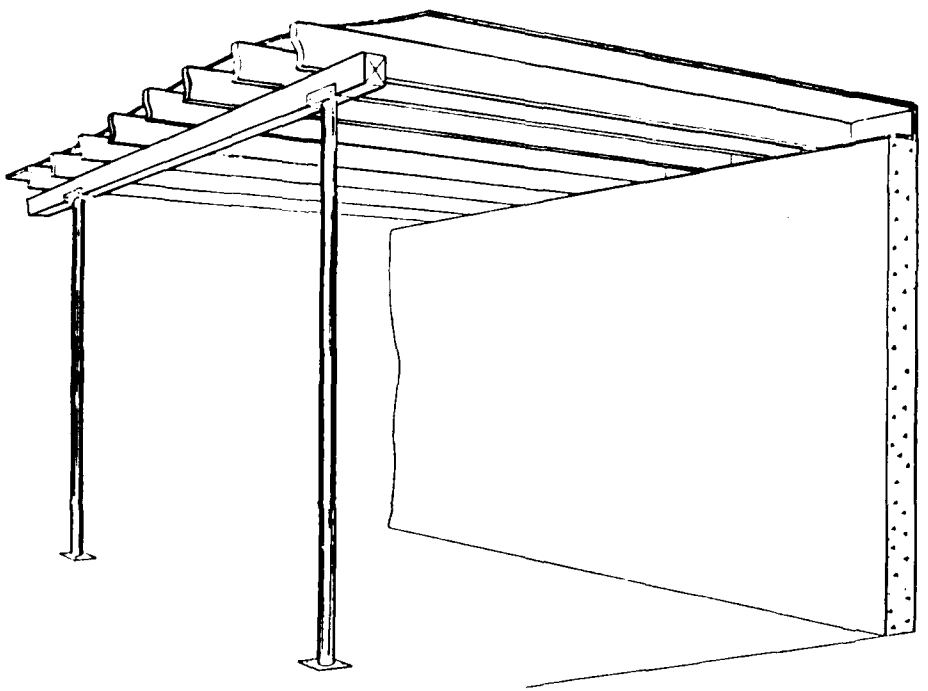
WOOD CONSTRUCTION - FLOOR

SURVIVAL RATING VI

TIMBER JOIST-LIGHT DESIGN

SUPERIMPOSED DESIGN LOAD-40 to 60 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40 100 1000	1 1.5 3	VI^+ VI 0	Page 6-1	Page 8-1	Page 7-1
Post and Beam Shores at Mid-span	40 100 1000	1 1.5 3	VI^+ VI 0	Page 6-2	Page 8-2, 8-3	Page 7-2
King Post Truss	40 100 1000	1 1.5 3	VI^+ VI^+ 0	Page 6-3		Page 7-3
Flange	40 100 1000	1 1.5 3	VI^+ VI^- †	Page 6-4		Page 7-4
Boxed Beam	40 100 1000	1 1.5 3	VI VI^- †	Page 6-5		Page 7-5



TYPICALLY FOUND IN RESIDENTIAL BASEMENTS AND SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 6 FT TO 18 FT, DEPTH OF JOIST 6 IN. TO 12 IN.

SUPPORT BEAM CAN BE EITHER STEEL OR WOOD, AND SUPPORT POSTS WOOD OR STEEL PIPE.

DESIGN CRITERION 40 - 60 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	+
1000	-	-

WOOD CONSTRUCTION–Floors

TIMBER JOIST–Light Design

AS BUILT

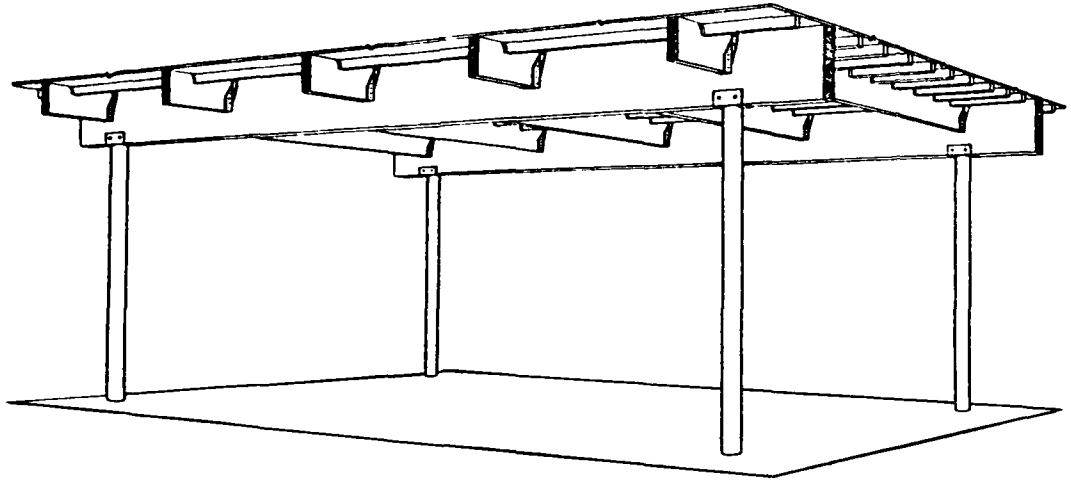
WOOD CONSTRUCTION - FLOOR

SURVIVAL RATING VI

GLULAM-LIGHT DESIGN

SUPERIMPOSED DESIGN LOAD-40 to 60 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40	1	VI$^+$	Page 6-6	Page 8-1	Page 7-1
	100	1.5	VI			
	1000	3	0			
Post and Beam Shores at Mid-span	40	1	VI$^+$	Page 6-7	Page 8-2, 8-3	Page 7-2
	100	1.5	VI			
	1000	3	0			
King Post Truss	40	1	VI$^+$	Page 6-8		Page 7-3
	100	1.5	VI$^+$			
	1000	3	0			



TYPICALLY FOUND IN SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 6 FT TO 18 FT, DEPTH OF GLULAM JOIST 4 IN. TO 8 IN., SUPPORTED ON GLULAM BEAM, NORMALLY 8 IN. TO 16 IN. DEEP.

SUPPORT POSTS WOOD OR STEEL PIPE.

DESIGN CRITERION 40 - 60 PSF

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	+
1000	-	-

WOOD CONSTRUCTION–Floors

GLULAM – Light Design

AS BUILT

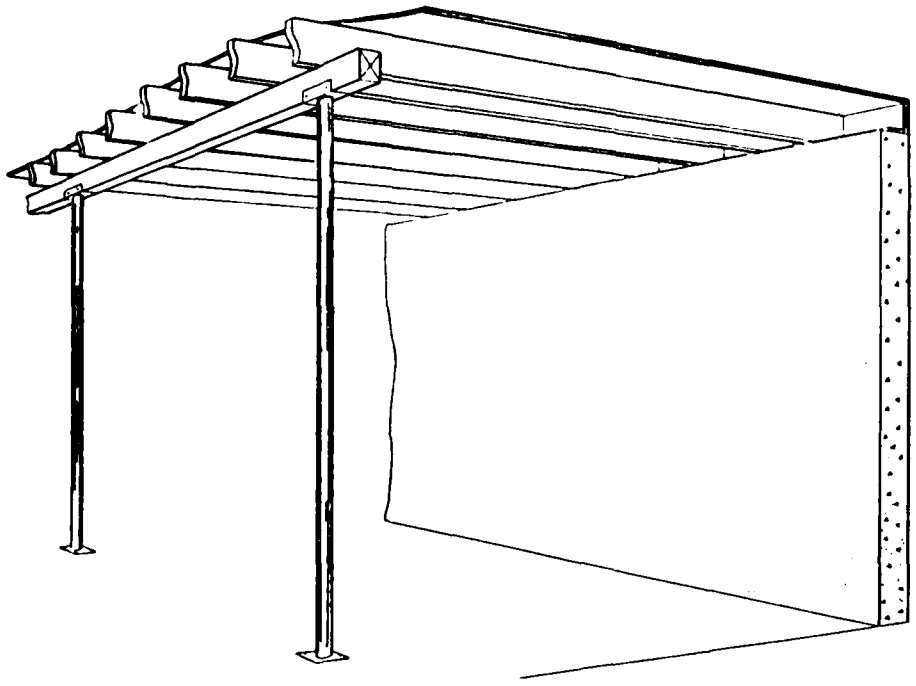
WOOD CONSTRUCTION - FLOOR

SURVIVAL RATING VI

TIMBER JOIST-MEDIUM DESIGN

SUPERIMPOSED DESIGN LOAD-80 to 125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-1	Page 8-1	Page 7-1
Post and Beam Shores at Mid-span	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-2	Page 8-2, 8-3	Page 7-2
King Post Truss	40 100 1000	1 1.5 3	VI+ VI+ VI+	Page 6-3		Page 7-3
Flange	40 100 1000	1 1.5 3	VI+ VI+ VI+	Page 6-4		Page 7-4
Boxed Beam	40 100 1000	1 1.5 3	VI+ VI+ VI+	Page 6-5		Page 7-5



TYPICALLY FOUND IN RETAIL STORES AND LIGHT MANUFACTURING BUILDINGS.

SPANS NORMALLY 6 FT TO 18 FT, DEPTH OF JOIST 6 IN. TO 12 IN.

SUPPORT BEAM CAN BE EITHER STEEL OR WOOD, AND SUPPORT POSTS, WOOD OR STEEL PIPE.

DESIGN CRITERION 80 TO 125 PSF

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	VI-
100	1.5	0
1000	3	+

WOOD CONSTRUCTION–Floors

TIMBER JOIST– Medium Design

AS BUILT

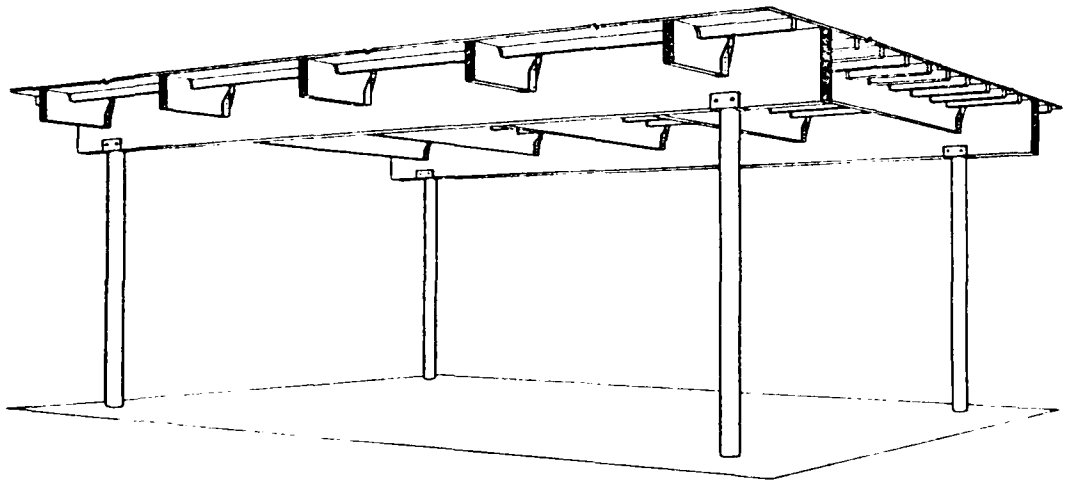
WOOD CONSTRUCTION - FLOOR

SURVIVAL RATING VI

GLULAM-MEDIUM DESIGN

SUPERIMPOSED DESIGN LOAD-80 to 125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40	1	VI$^+$	Page 6-6	Page 8-1	Page 7-1
	100	1.5	VI			
	1000	3	0			
Post and Beam Shores at Mid-span	40	1	VI$^+$	Page 6-7	Page 8-2, 8-3	Page 7-2
	100	1.5	VI			
	1000	3	0			
King Post Truss	40	1	VI$^+$	Page 6-8		Page 7-3
	100	1.5	VI$^+$			
	1000	3	VI$^+$			



TYPICALLY FOUND IN RETAIL STORES AND LIGHT MANUFACTURING BUILDINGS.

SPANS NORMALLY 6 FT TO 18 FT, DEPTH OF GLULAM JOIST, 6 IN. TO 8 IN., SUPPORTED ON GLULAM BEAM, NORMALLY 8 IN. TO 16 IN. DEEP.

SUPPORT POSTS WOOD OR STEEL PIPE.

DESIGN CRITERION 80 - 125 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	VI-
100	1.5	0
1000	-	+

WOOD CONSTRUCTION–Floors

GLULAM – Medium Design

AS BUILT

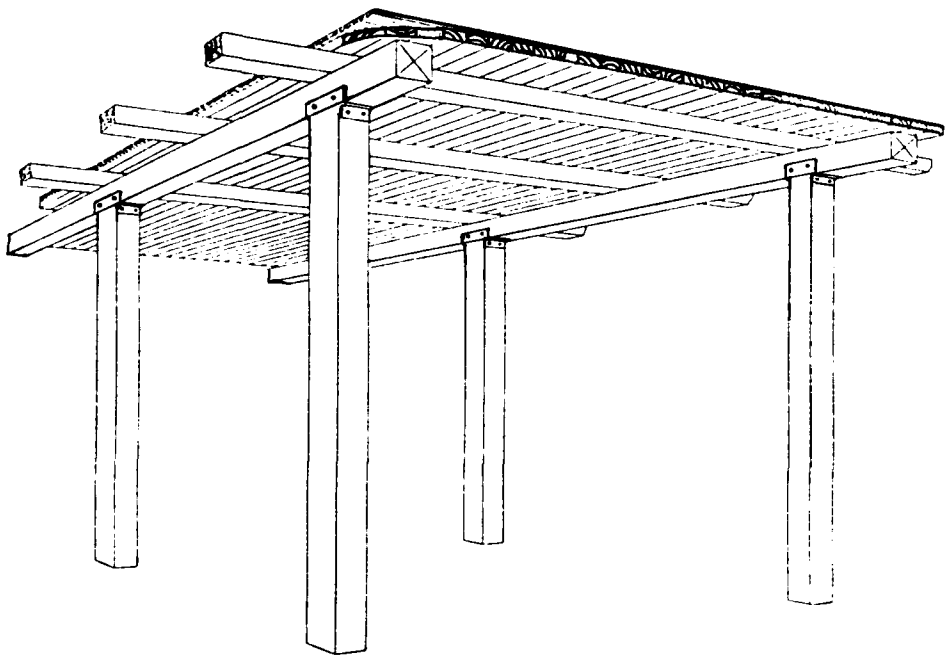
WOOD CONSTRUCTION - FLOOR

SURVIVAL RATING VI

TIMBER PLANK-HEAVY DESIGN

SUPERIMPOSED DESIGN LOAD 150 to 250 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
None Required	40	1	VI+	DOES NOT REQUIRE UPGRADING		
	100	1.5	VI+			
	1000	3	VI+			



TYPICALLY FOUND IN HEAVY MANUFACTURING BUILDINGS AND STORAGE WAREHOUSES.

SPANS NORMALLY 6 FT TO 18 FT. BEAM MINIMUM 4 IN. BY 4 IN. SIZE, GIRDERS MINIMUM 8 IN. BY 8 IN. SIZE.

PLANK FLOOR MINIMUM 3 IN. TIMBER. COLUMNS USUALLY TIMBER, MINIMUM 8 IN. BY 8 IN.

DESIGN CRITERION 150 - 250 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	VI^+
100	1.5	VI^+
1000	3	VI^+

WOOD CONSTRUCTION–Floors

TIMBER PLANK–Heavy Design

AS BUILT

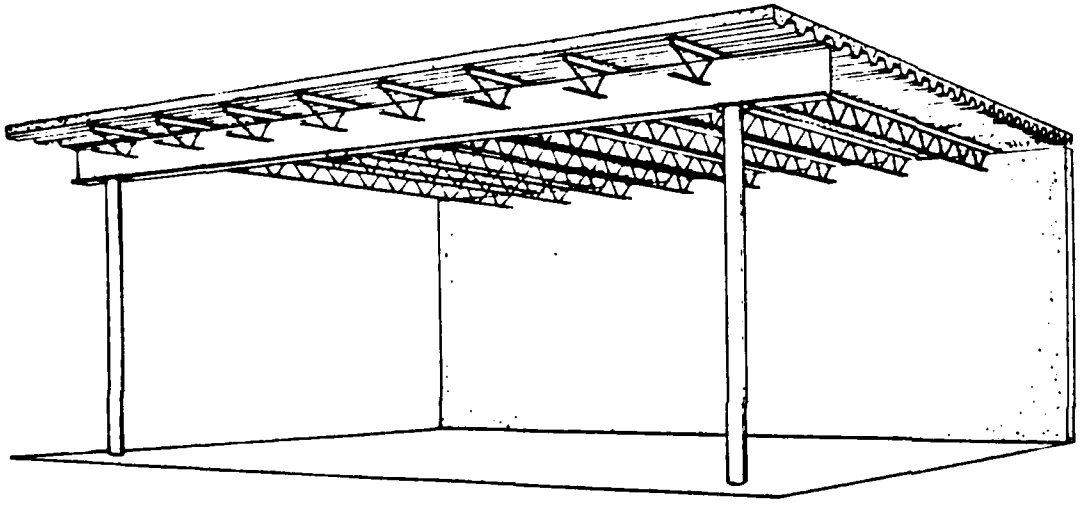
STEEL - LIGHT CONSTRUCTION - FLOOR

SURVIVAL RATING VI

OPEN-WEB JOIST - LIGHT DESIGN

SUPERIMPOSED DESIGN LOAD-40 to 60 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40	1	VI+	Page 6-9	Page 8-1	Page 7-1
	100	1.5	VI			
	1000	3	0			
Post and Beam Shores at Mid-span	40	1	VI+	Page 6-10	Page 8-2, 8-3	Page 7-2
	100	1.5	VI			
	1000	3	0			



TYPICALLY FOUND IN SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 8 FT TO 26 FT. OPEN-WEB JOIST DEPTH 8 IN. TO 16 IN.

SUPPORT BEAM NORMALLY STEEL.

DESIGN CRITERION 40 - 60 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	+
1000	-	-

STEEL–LIGHT CONSTRUCTION–Floors

OPEN–WEB JOIST–Light Design

AS BUILT

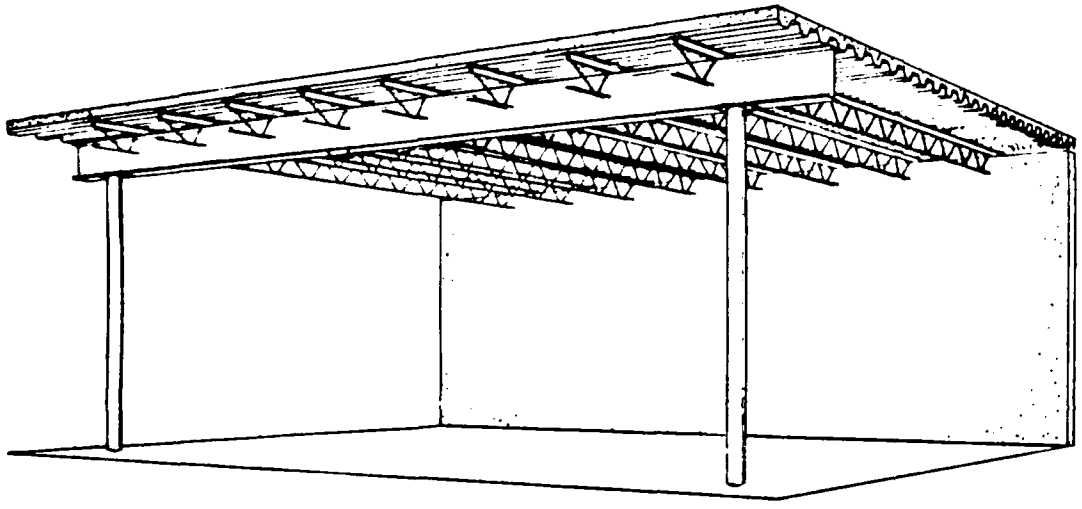
STEEL - LIGHT CONSTRUCTION - FLOOR

SURVIVAL RATING VI

OPEN-WEB JOIST - MEDIUM DESIGN

SUPERIMPOSED DESIGN LOAD-80 to 125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40	1	VI$^+$	Page 6-9	Page 8-1	Page 7-1
	100	1.5	VI			
	1000	3	0			
Post and Beam Shores at Mid-span	40	1	VI$^+$	Page 6-10	Page 8-2, 8-3	Page 7-2
	100	1.5	VI			
	1000	3	0			
King Post Truss	40	1	VI$^+$	Page 6-11		Page 7-3
	100	1.5	VI$^+$			
	1000	3	0			



TYPICALLY FOUND IN RETAIL STORES AND LIGHT MANUFACTURING BUILDINGS.

SPANS NORMALLY 8 FT TO 28 FT. OPEN-WEB JOIST DEPTH 8 IN. TO 20 IN.

SUPPORT BEAM NORMALLY STEEL.

DESIGN CRITERION 80 - 125 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	0
1000	3	+

STEEL–LIGHT CONSTRUCTION–Floors

OPEN–WEB JOIST–Medium Design

AS BUILT

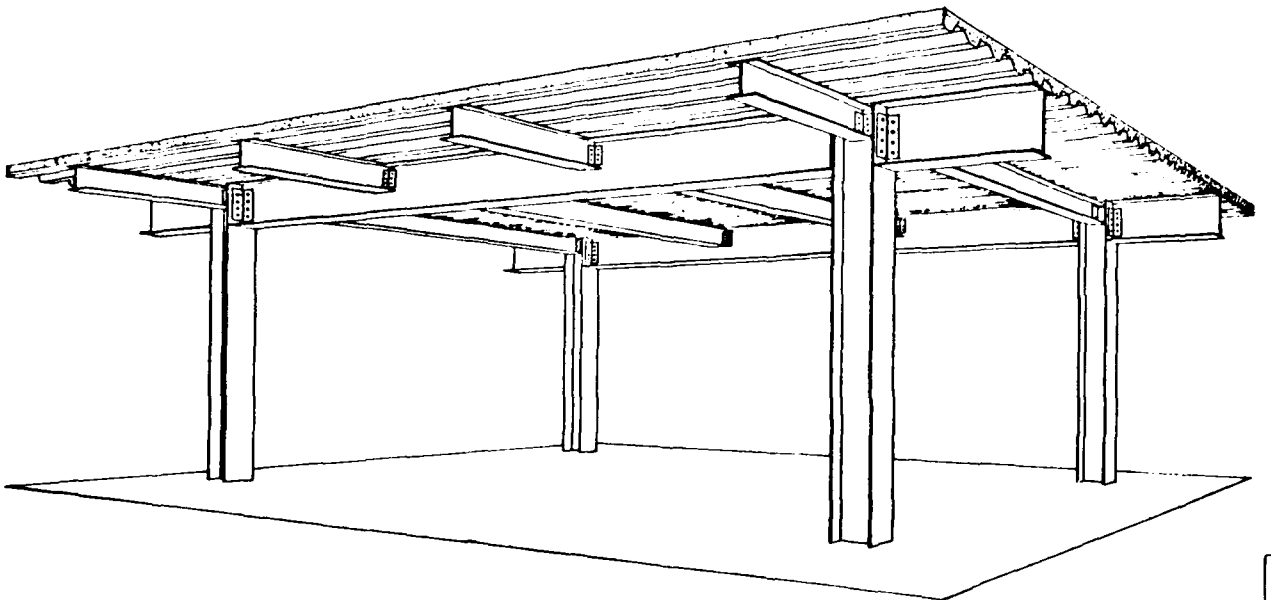
STEEL - HEAVY CONSTRUCTION - FLOOR

SURVIVAL RATING VI

BEAM AND SLAB-LIGHT DESIGN

SUPERIMPOSED DESIGN LOAD-40 to 60 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-12	Page 8-1	Page 7-1
Post and Beam Shores at Midspan	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-13	Page 8-2, 8-3	Page 7-2



TYPICALLY FOUND IN SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 6 FT TO 18 FT, DEPTH OF BEAMS 4 IN. TO 8 IN., SUPPORTED ON STEEL GIRDER, NORMALLY 8 IN. TO 12 IN. DEEP.

SUPPORT COLUMNS NORMALLY STEEL.

DESIGN CRITERION 40 - 60 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	0
1000	3	+

STEEL–HEAVY CONSTRUCTION–Floors

BEAM AND SLAB–Light Design

AS BUILT

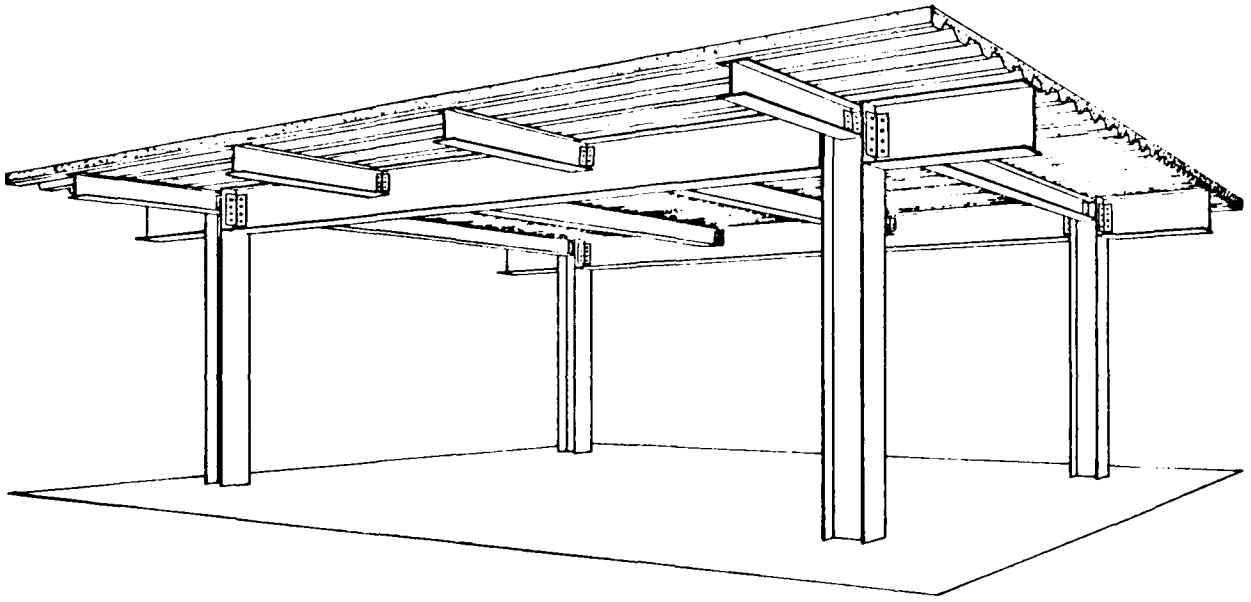
STEEL - HEAVY CONSTRUCTION - FLOOR

SURVIVAL RATING VI

BEAM AND SLAB-MEDIUM DESIGN

SUPERIMPOSED DESIGN LOAD-80 to 125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40 100 1000	0.5 1 2.5	VI+ VI 0	Page 6-12	Page 8-1	Page 7-1
Post and Beam Shores at Mid-span	40 100 1000	0.5 1 2.5	VI+ VI 0	Page 6-13	Page 8-2, 8-3	Page 7-2



TYPICALLY FOUND IN RETAIL STORES AND LIGHT MANUFACTURING BUILDINGS.

SPANS NORMALLY 6 FT TO 20 FT. DEPTH OF BEAMS 6 IN. TO 8 IN., SUPPORTED ON STEEL GIRDER, NORMALLY 8 IN. TO 16 IN. DEEP.

SUPPORT COLUMNS NORMALLY STEEL.

DESIGN CRITERION 80 - 125 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	0
100	1	0
1000	2.5	+

STEEL–HEAVY CONSTRUCTION–Floors

BEAM AND SLAB–Medium Design

AS BUILT

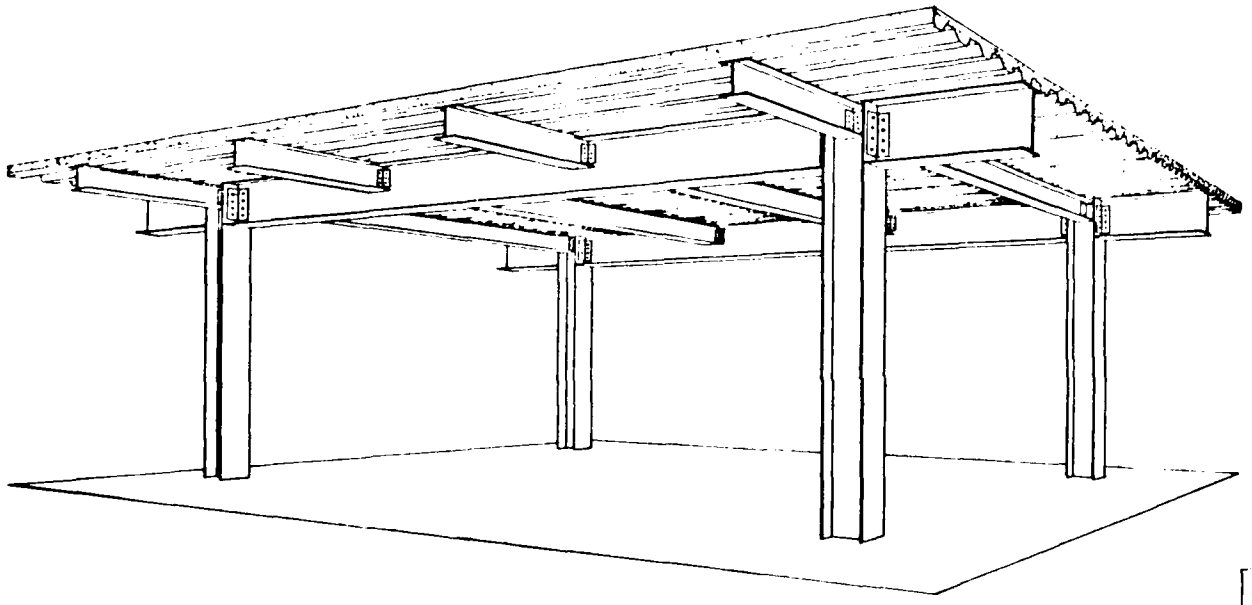
STEEL - HEAVY CONSTRUCTION - FLOOR

SURVIVAL RATING VI

BEAM AND SLAB-HEAVY DESIGN

SUPERIMPOSED DESIGN LOAD-150 to 250 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
None Required	40	0.5	VI+	DOES NOT REQUIRE UPGRADING		
	100	1	VI			
	1000	2.5	0			



TYPICALLY FOUND IN HEAVY MANUFACTURING BUILDINGS AND STORAGE WAREHOUSES.

SPANS NORMALLY 10 FT TO 24 FT, DEPTH OF BEAMS 8 IN. TO 10 IN., SUPPORTED ON STEEL GIRDERS, NORMALLY 12 IN. TO 24 IN. DEEP.

SUPPORT COLUMN NORMALLY STEEL.

DESIGN CRITERION 150 - 250 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	VI+
100	1	VI
1000	2.5	0

STEEL–HEAVY CONSTRUCTION–Floors

BEAM AND SLAB–Heavy Design

AS BUILT

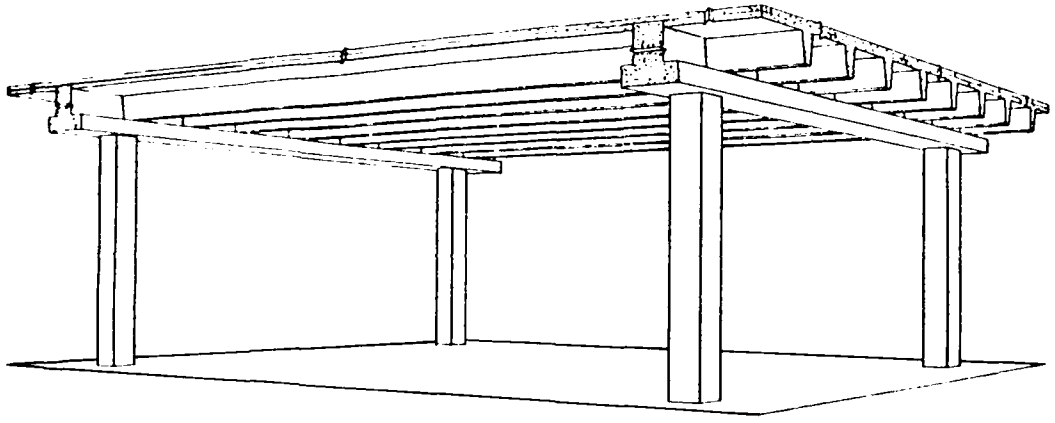
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

DOUBLE TEES- LIGHT DESIGN

SUPERIMPOSED DESIGN LOAD-40 to 60 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40	0.5	VI+	Page 6-14	Page 8-1	Page 7-1
	100	1	VI			
	1000	2.5	0			
Post and Beam Shores at Mid-span	40	0.5	VI+	Page 6-15	Page 8-2, 8-3	Page 7-2
	100	1	VI			
	1000	2.5	0			



TYPICALLY FOUND IN SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 12 FT TO 24 FT
STEMS 6 IN. TO 14 IN. DEEP.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DESIGN CRITERION 40 TO 60 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	0
100	1	0
1000	2.5	+

CONCRETE CONSTRUCTION–Floors

DOUBLE TEE – Light Design

AS BUILT

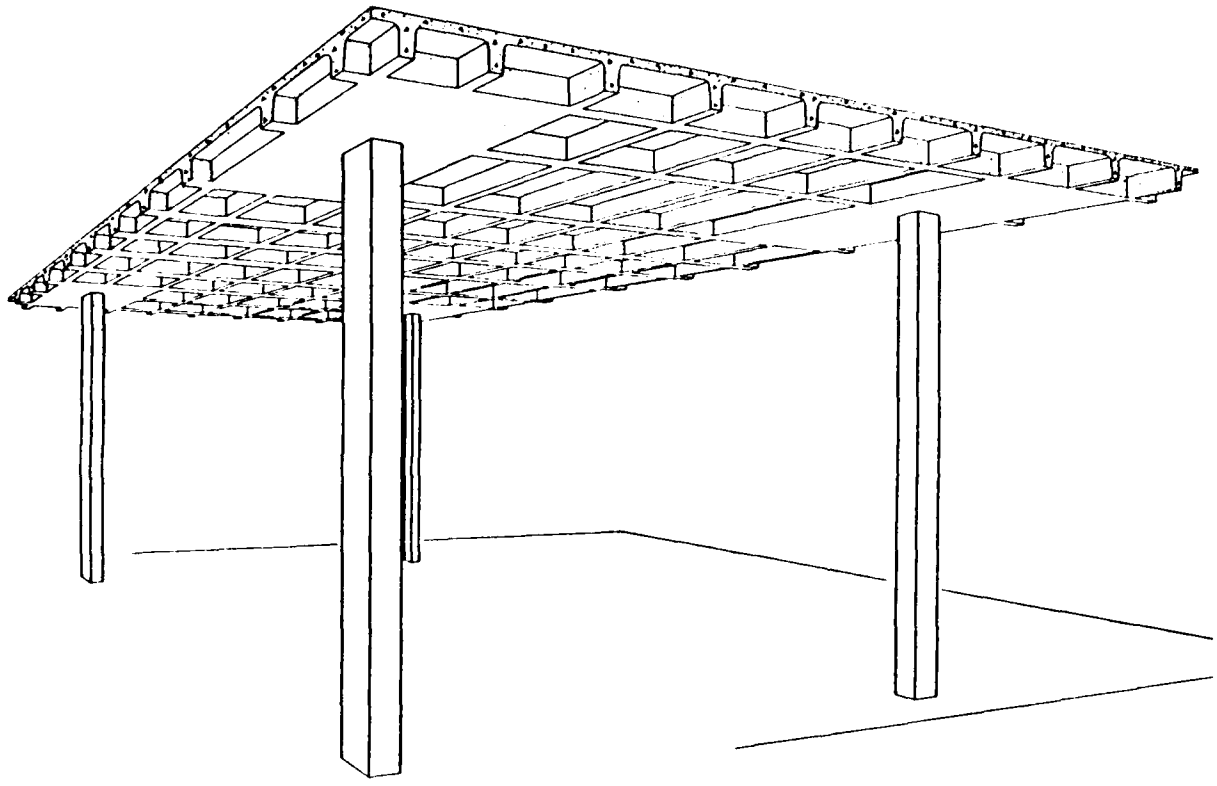
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

WAFFLE SLAB-LIGHT DESIGN

SUPERIMPOSED DESIGN LOAD-40 to 60 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Post Shores at Midspan	40	0.5	VI+	Page 6-16	Page 8-4	Page 7-6
	100	1	VI			
	1000	2.5	0			



TYPICALLY FOUND IN SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 15 FT TO 36 FT.

RIBS 8 IN. TO 12 IN. DEEP.

CONCRETE COLUMNS.

DESIGN CRITERION 40 TO 60 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	0
100	1	0
1000	2.5	+

CONCRETE CONSTRUCTION–Floors

WAFFLE SLAB– Light Design

AS BUILT

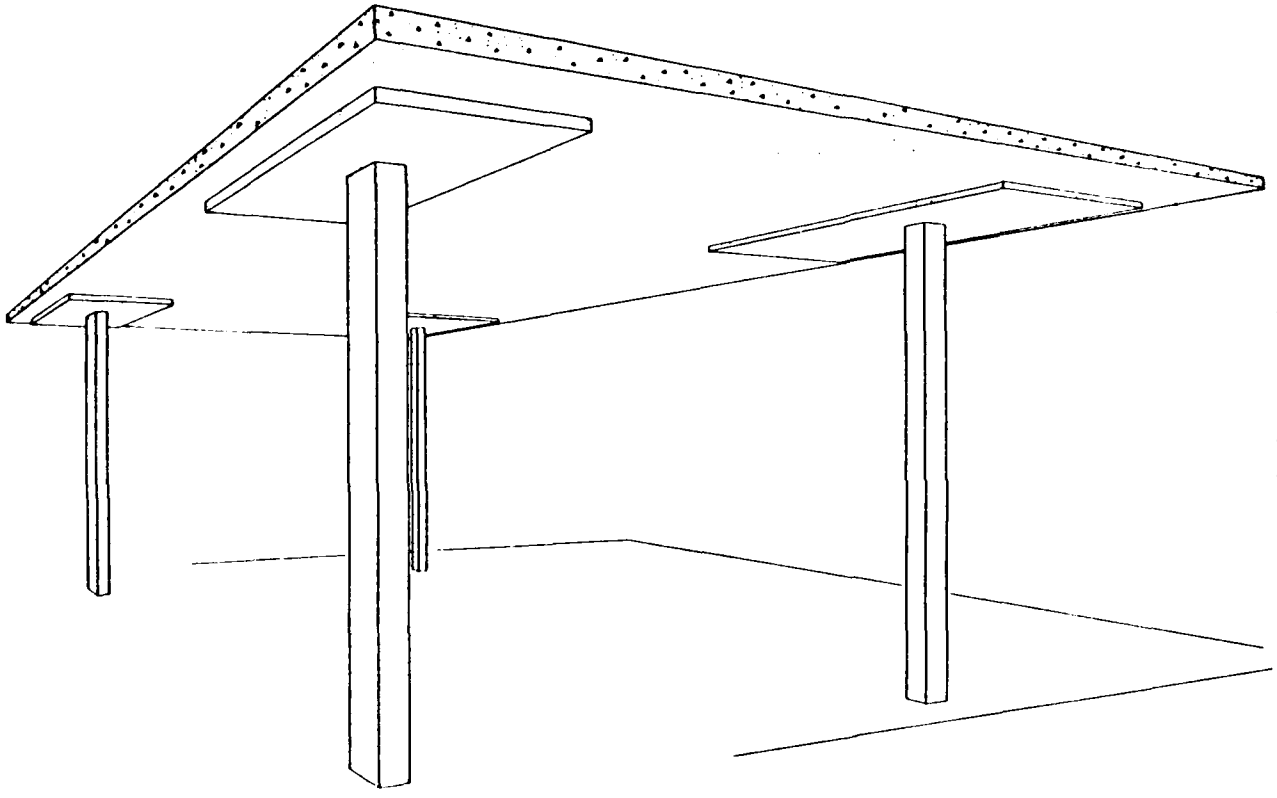
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

FLAT SLAB - LIGHT DESIGN

SUPERIMPOSED DESIGN LOAD-40 to 60 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Post Shores at Midspan	40	N	VI^+	Page 6-17	Page 8-4	Page 7-6
	100	0.5	VI^+			
	1000	2	0			



TYPICALLY FOUND IN SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 15 FT TO 24 FT.

SLAB 6 IN. TO 10 IN. THICK.

CONCRETE COLUMNS.

DESIGN CRITERION 40 TO 60 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	N	0
100	0.5	0
1000	2	0

CONCRETE CONSTRUCTION–Floors

FLAT SLAB – Light Design

AS BUILT

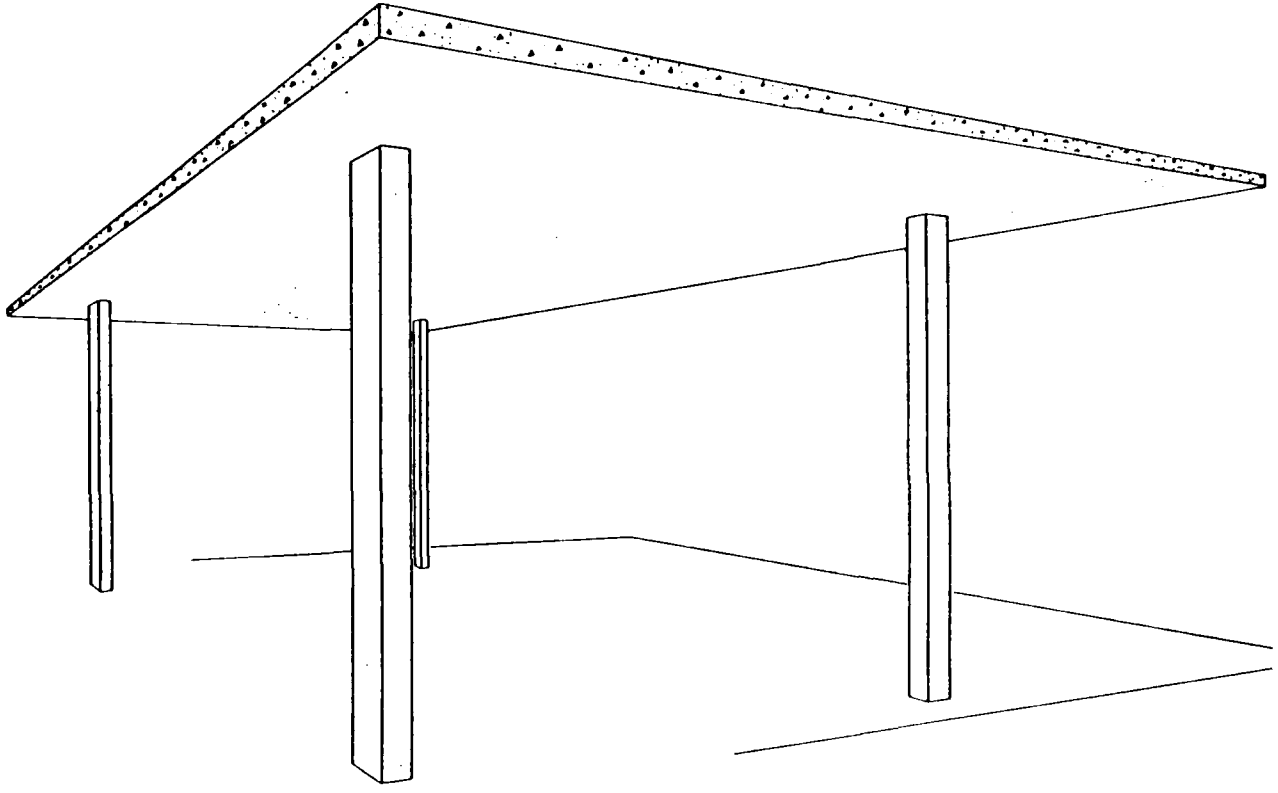
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

FLAT PLATE - LIGHT DESIGN

SUPERIMPOSED DESIGN LOAD-40 to 60 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Post Shores at Midspan	40	N	VI$^+$	Page 6-18	Page 8-1	Page 7-6
	100	0.5	VI$^+$			
	1000	2	0			



TYPICALLY FOUND IN SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 12 FT TO 26 FT.

SLAB 5 IN. TO 10 IN. THICK.

CONCRETE COLUMNS.

DESIGN CRITERION 40 - 60 PSF.

PADIATION		SURVIVAL RATING
P_F	KEY	
40	N	0
100	0.5	0
1000	2	0

CONCRETE CONSTRUCTION–Floors

FLAT PLATE – Light Design

AS BUILT

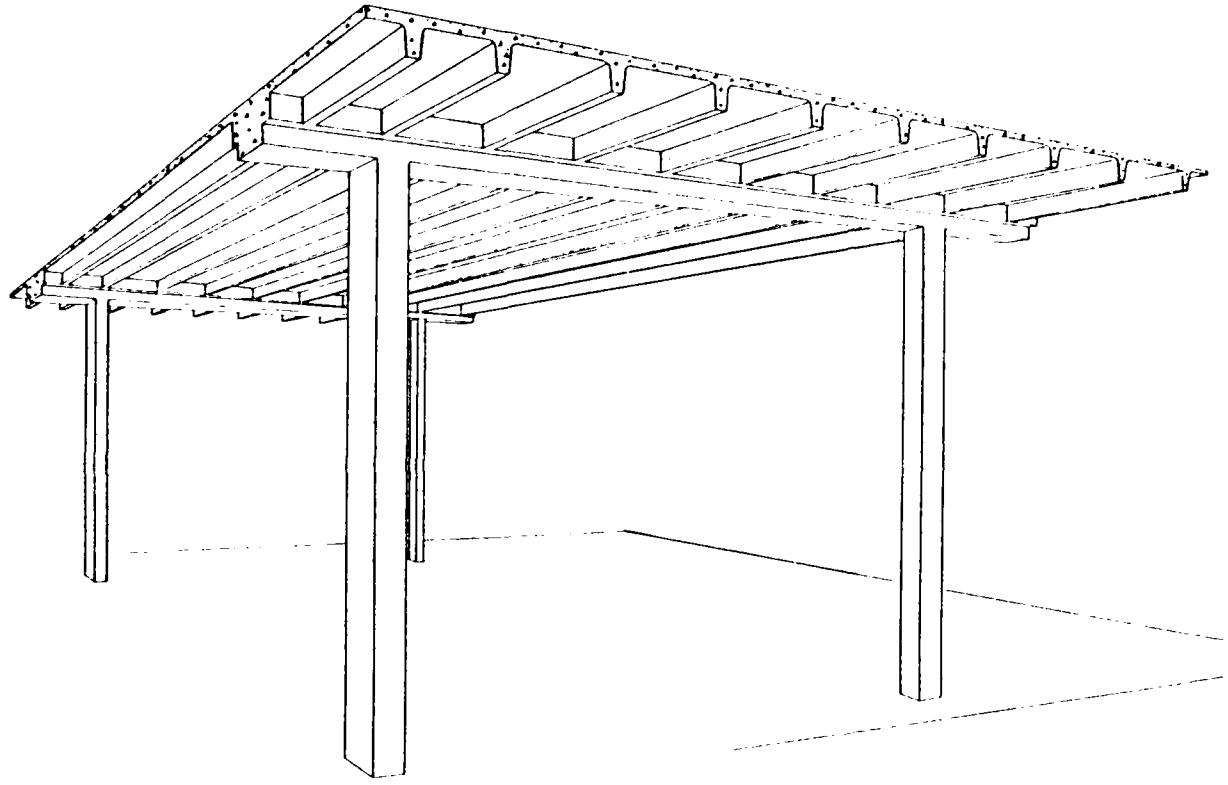
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

ONE-WAY JOIST - LIGHT DESIGN

SUPERIMPOSED DESIGN LOAD-40 to 60 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40	0.5	VI+	Page 6-19	Page 8-1	Page 7-1
	100	1	VI			
	1000	2.5	0			
Post and Beam Shores at Mid-span	40	0.5	VI+	Page 6-20	Page 8-2, 8-3	Page 7-2
	100	1	VI			
	1000	2.5	0			



TYPICALLY FOUND IN SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 14 FT TO 26 FT.

RIBS 8 IN. TO 12 IN. DEEP.

CONCRETE COLUMNS.

DESIGN CRITERION 40 - 60 PSF.

RADIATION		SURVIVAL RATING
PF	KEY	
40	0.5	0
100	1	0
1000	2.5	+

CONCRETE CONSTRUCTION–Floors

ONE–WAY JOIST– Light Design

AS BUILT

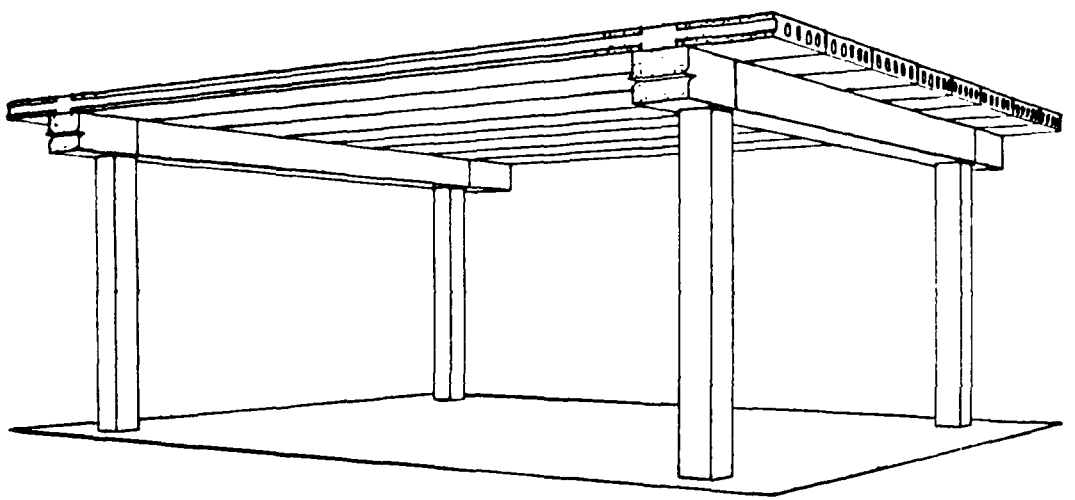
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

HOLLOW-CORE - LIGHT DESIGN

SUPERIMPOSED DESIGN LOAD-40 to 60 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40 100 1000	0.5 1 2.5	VI+ VI 0	Page 6-21	Page 8-1	Page 7-1
Post and Beam Shores at Mid-span	40 100 1000	0.5 1 2.5	VI+ VI 0	Page 6-22	Page 8-2, 8-3	Page 7-2



TYPICALLY FOUND IN SMALL COMMERCIAL BUILDINGS.

SPANS NORMALLY 12 FT TO 34 FT.

SLAB 4 IN. TO 8 IN. THICK.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DESIGN CRITERION 40 TO 60 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	0
100	1	0
1000	2.5	+

CONCRETE CONSTRUCTION–Floors

HOLLOW-CORE – Light Design

AS BUILT

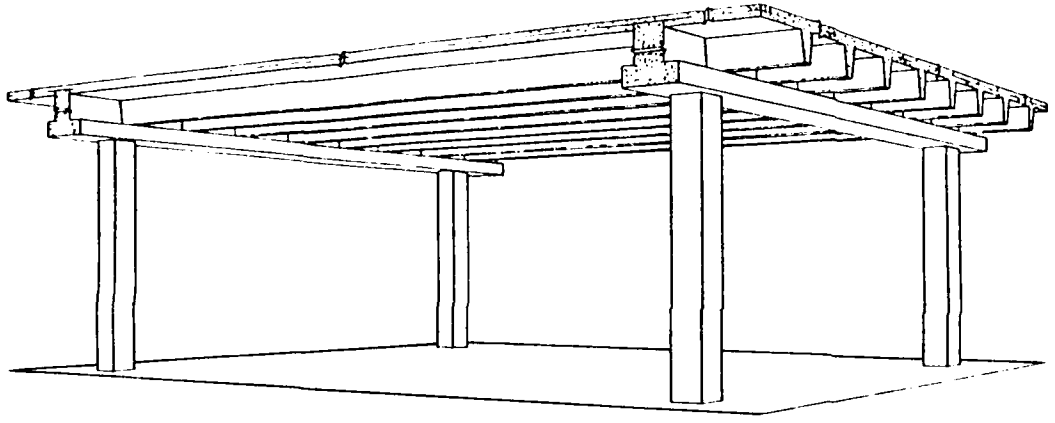
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

DOUBLE TEES - MEDIUM DESIGN

SUPERIMPOSED DESIGN LOAD- 80 to125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40 100 1000	0.5 1 2:5	VI+ VI 0	Page 6-14	Page 8-1	Page 7-1
Post and Beam Shores at Mid-span	40 100 1000	0.5 1 2.5	VI+ VI 0	Page 6-15	Page 8-2, 8-3	Page 7-2



TYPICALLY FOUND IN RETAIL STORES AND LIGHT MANUFACTURING BUILDINGS.

SPANS NORMALLY 18 FT TO 30 FT.

STEMS 12 IN. TO 18 IN. DEEP.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DESIGN CRITERION 80 TO 125 PSF.

RADIATION		SURVIVAL RATING
PF	KEY	
40	0.5	0
100	1	0
1000	2.5	0

CONCRETE CONSTRUCTION–Floors

DOUBLE TEE – Medium Design

AS BUILT

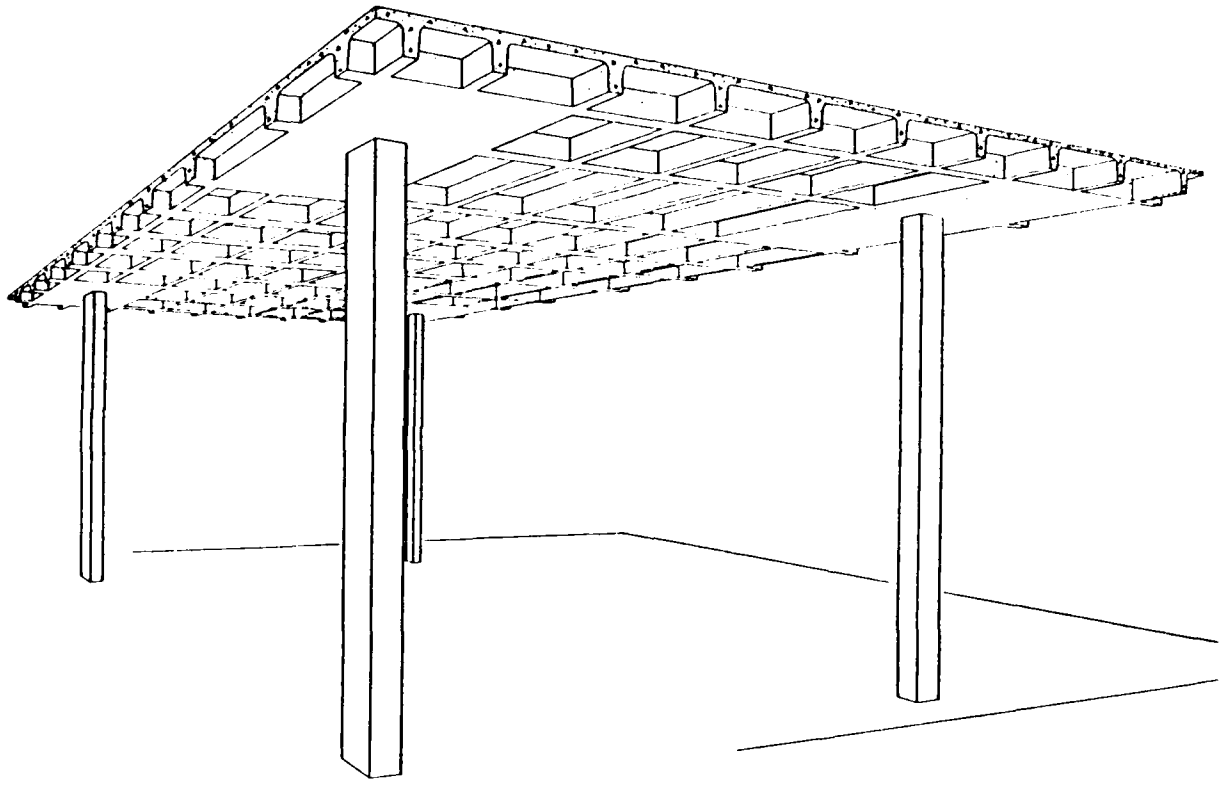
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

WAFFLE SLAB-MEDIUM DESIGN

SUPERIMPOSED DESIGN LOAD-80 to 125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Post Shores at Midspan	40	0.5	VI+	Page 6-16	Page 8-4	Page 7-6
	100	1	VI			
	1000	2.5	0			



TYPICALLY FOUND IN RETAIL STORES AND LIGHT MANUFACTURING BUILDINGS.

SPANS NORMALLY 15 FT TO 36 FT.

RIBS 10 IN. TO 14 IN. DEEP.

CONCRETE COLUMNS.

DESIGN CRITERION 80 TO 125 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	0
100	1	0
1000	2.5	0

CONCRETE CONSTRUCTION—Floors

WAFFLE SLAB—Medium Design

AS BUILT

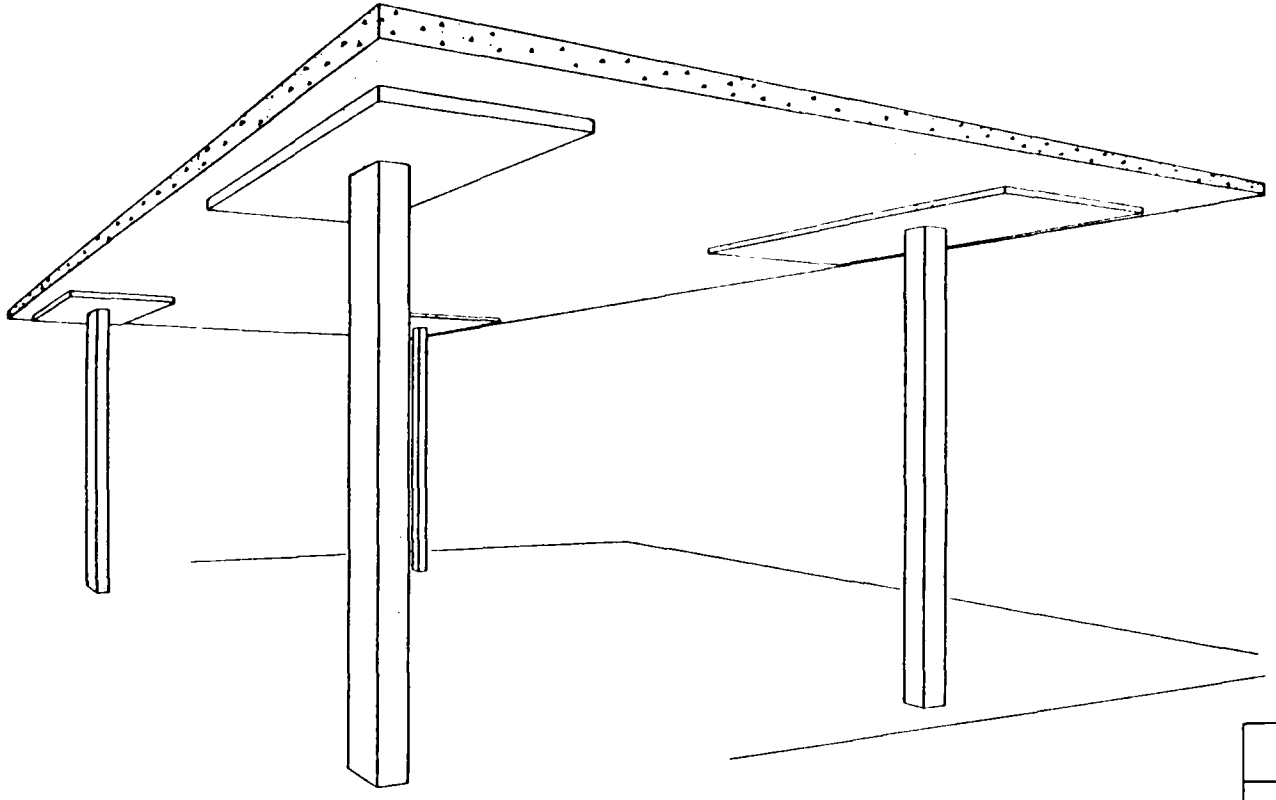
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

FLAT SLAB - MEDIUM DESIGN

SUPERIMPOSED DESIGN LOAD- 80 to 125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Post Shores at Midspan	40 100 1000	N 0.5 2	VI+ VI 0	Page 6-17	Page 8-4	Page 7-6



TYPICALLY FOUND IN RETAIL STORES AND LIGHT MANUFACTURING BUILDINGS.

SPANS NORMALLY 18 FT TO 30 FT.

SLAB 8 IN. TO 10 IN. THICK.

CONCRETE COLUMNS.

DESIGN CRITERION 80 - 125 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	N	VI
100	0.5	0
1000	2	0

CONCRETE CONSTRUCTION–Floors

FLAT SLAB – Medium Design

AS BUILT

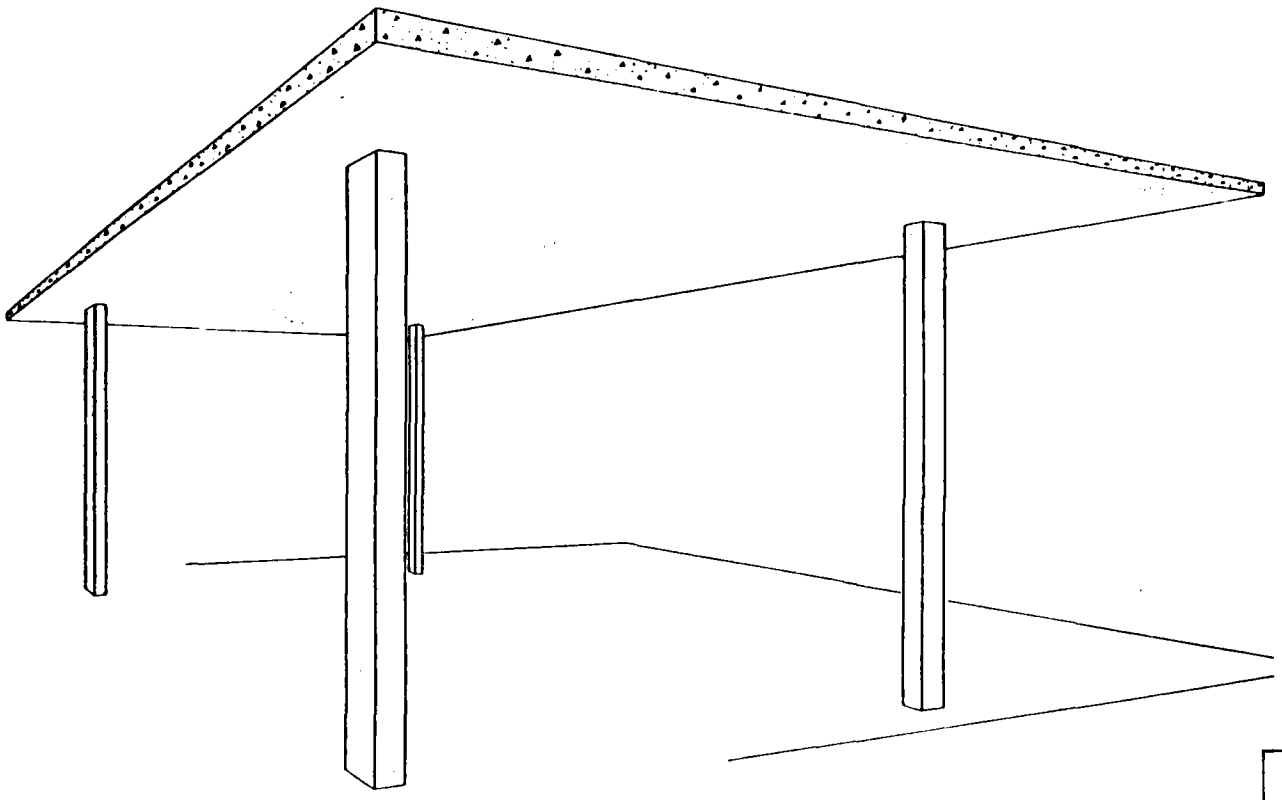
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

FLAT PLATE - MEDIUM DESIGN

SUPERIMPOSED DESIGN LOAD- 80 to 125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Post Shores at Midspan	40 100 1000	N 0.5 2	VI+ VI 0	Page 6-18	Page 8-4	Page 7-6



TYPICALLY FOUND IN RETAIL STORES AND LIGHT MANUFACTURING BUILDINGS.

SPANS NORMALLY 16 FT TO 26 FT.

SLAB 6 IN. TO 10 IN. THICK.

CONCRETE COLUMNS.

DESIGN CRITERION 80 - 125 PSF.

RADIATION		SURVIVAL RATING
PF	KEY	
40	N	VI
100	0.5	0
1000	2	0

CONCRETE CONSTRUCTION–Floors

FLAT PLATE – Medium Design

AS BUILT

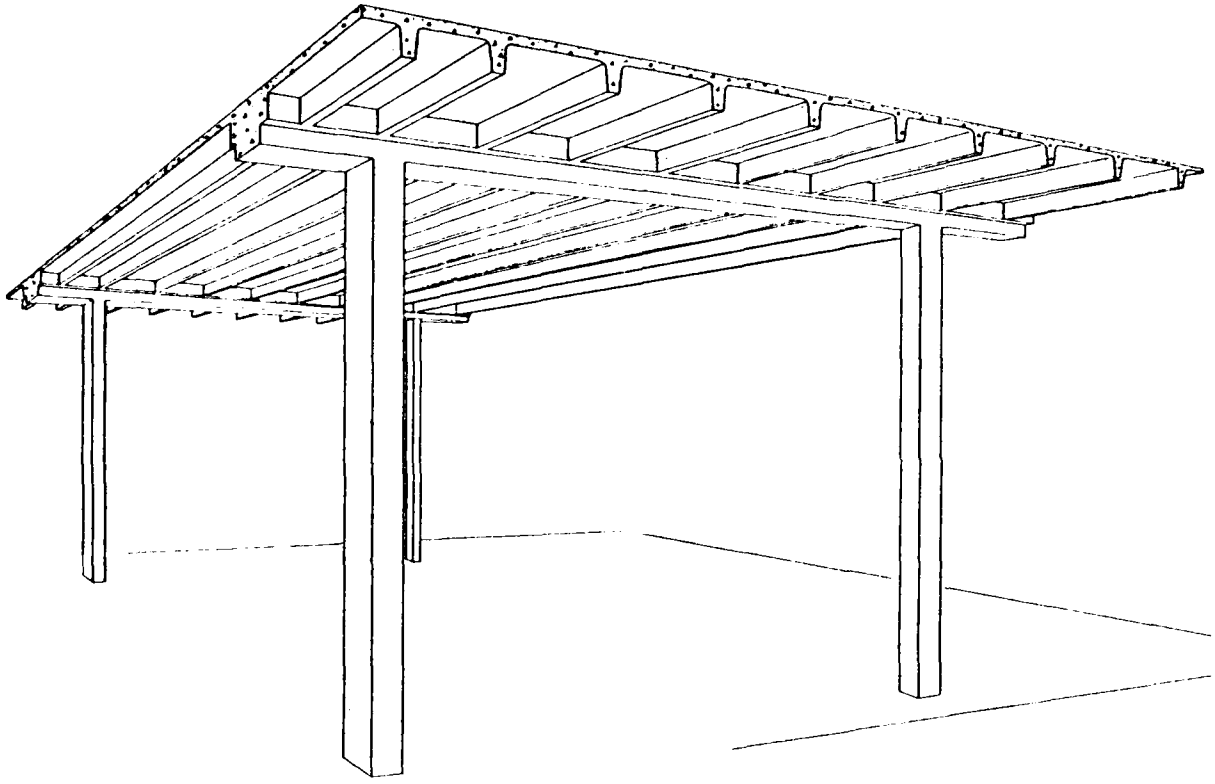
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

ONE-WAY JOIST - MEDIUM DESIGN

SUPERIMPOSED DESIGN LOAD- 80 to125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40	0.5	VI+	Page 6-19	Page 8-1	Page 7-1
	100	1	VI			
	1000	2.5	0			
Post and Beam Shores at Mid-span	40	0.5	VI+	Page 6-20	Page 8-2, 8-3	Page 7-2
	100	1	VI			
	1000	2.5	0			



TYPICALLY FOUND IN RETAIL STORES AND LIGHT MANUFACTURING BUILDINGS.

SPANS NORMALLY 16 FT TO 28 FT.

RIBS 10 IN. TO 14 IN. DEEP.

CONCRETE COLUMNS.

DESIGN CRITERION 80 TO 125 PSF.

PADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	0
100	1	0
1000	2.5	0

CONCRETE CONSTRUCTION–Floors

ONE–WAY JOIST– Medium Design

AS BUILT

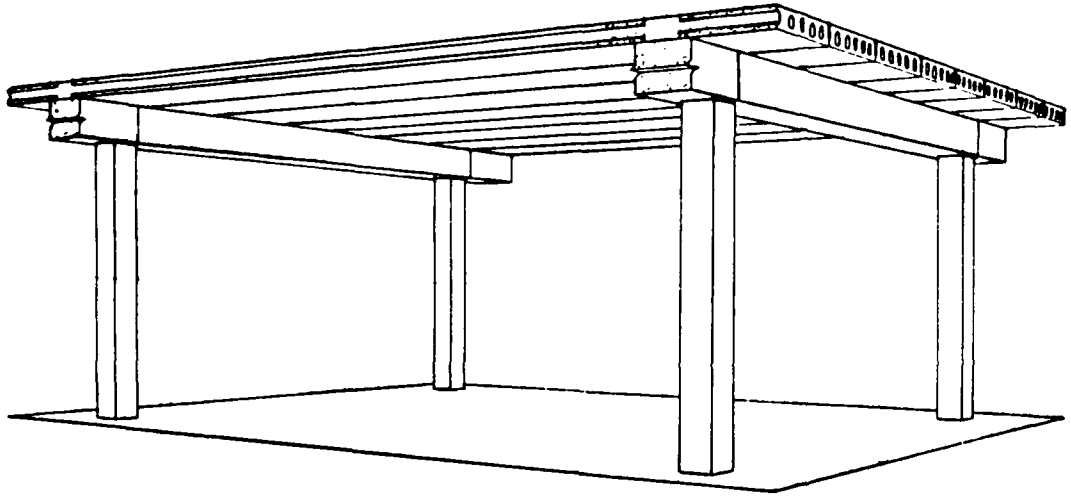
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

HOLLOW-CORE - MEDIUM DESIGN

SUPERIMPOSED DESIGN LOAD- 80 to125 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40	0.5	VI+	Page 6-21	Page 8-1	Page 7-1
	100	1	VI			
	1000	2.5	0			
Post and Beam Shores at Mid-span	40	0.5	VI+	Page 6-22	Page 8-2, 8-3	Page 7-2
	100	1	VI			
	1000	2.5	0			



TYPICALLY FOUND IN RETAIL STORES AND LIGHT MANUFACTURING BUILDINGS.

SPANS NORMALLY 16 FT TO 30 FT.

SLAB 6 IN. TO 10 IN. THICK.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DESIGN CRITERION 80 TO 125 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	0
100	1	0
1000	2.5	0

CONCRETE CONSTRUCTION–Floors

HOLLOW–CORE – Medium Design

AS BUILT

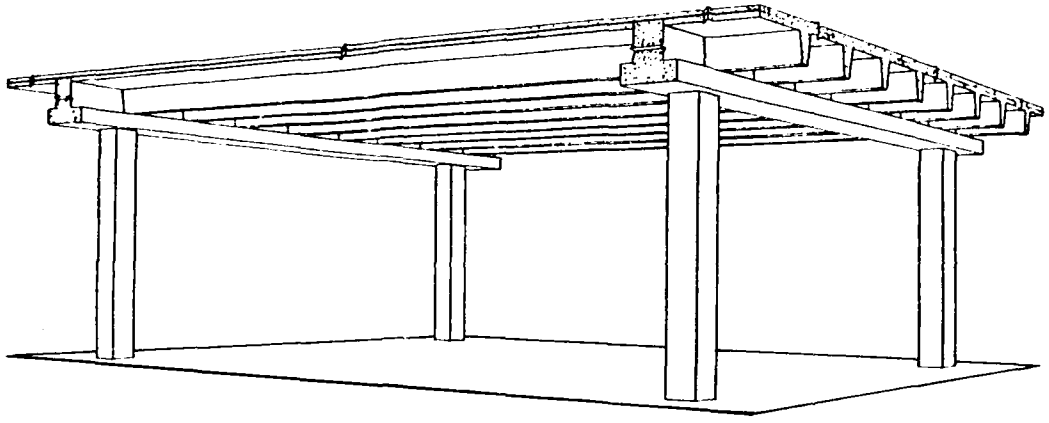
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

DOUBLE TEES - HEAVY DESIGN

SUPERIMPOSED DESIGN LOAD-150 to 250 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
None Required	40	0.5	VI+	DOES NOT REQUIRE UPGRADING		
	100	1	VI+			
	1000	2.5	VI			



TYPICALLY FOUND IN HEAVY MANUFACTURING BUILDINGS AND STORAGE WAREHOUSES.

SPANS NORMALLY 18 FT TO 30 FT.

STEMS 16 IN. TO 32 IN. DEEP.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DESIGN CRITERION 150 TO 250 PSF.

RADIATION		SURVIVAL RATING
PF	KEY	
40	0.5	VI+
100	1	VI+
1000	2.5	VI

CONCRETE CONSTRUCTION–Floors

DOUBLE TEE – Heavy Design

AS BUILT

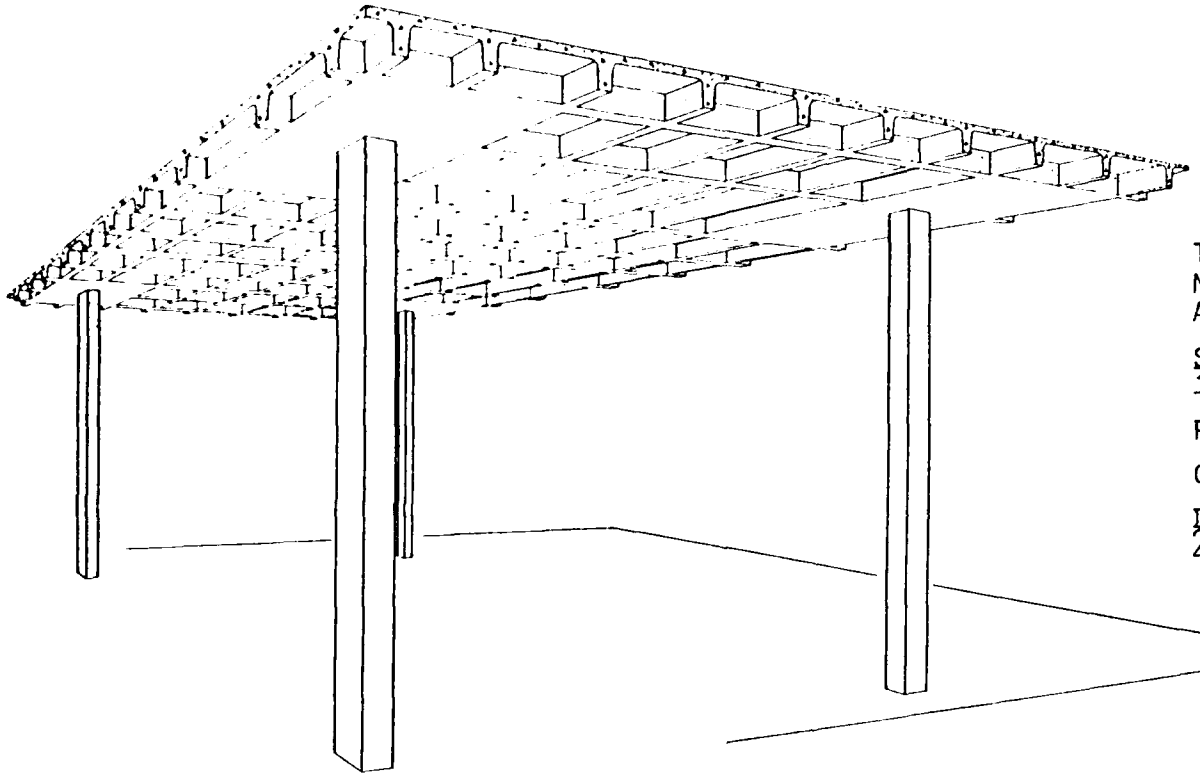
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

WAFFLE SLABS - HEAVY DESIGN

SUPERIMPOSED DESIGN LOAD-150 to 250 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
None Required	40	0.5	VI+	DOES NOT REQUIRE UPGRADING		
	100	1	VI+			
	1000	2.5	VI			



TYPICALLY FOUND IN HEAVY MANUFACTURING BUILDINGS AND STORAGE WAREHOUSES.

SPANS NORMALLY 15 FT TO 36 FT.

RIBS 10 IN. TO 16 IN. DEEP.

CONCRETE COLUMNS.

DESIGN CRITERION 150 TO 250 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	VI$^+$
100	1	VI$^+$
1000	2.5	VI

CONCRETE CONSTRUCTION–Floors

WAFFLE SLAB– Heavy Design

AS BUILT

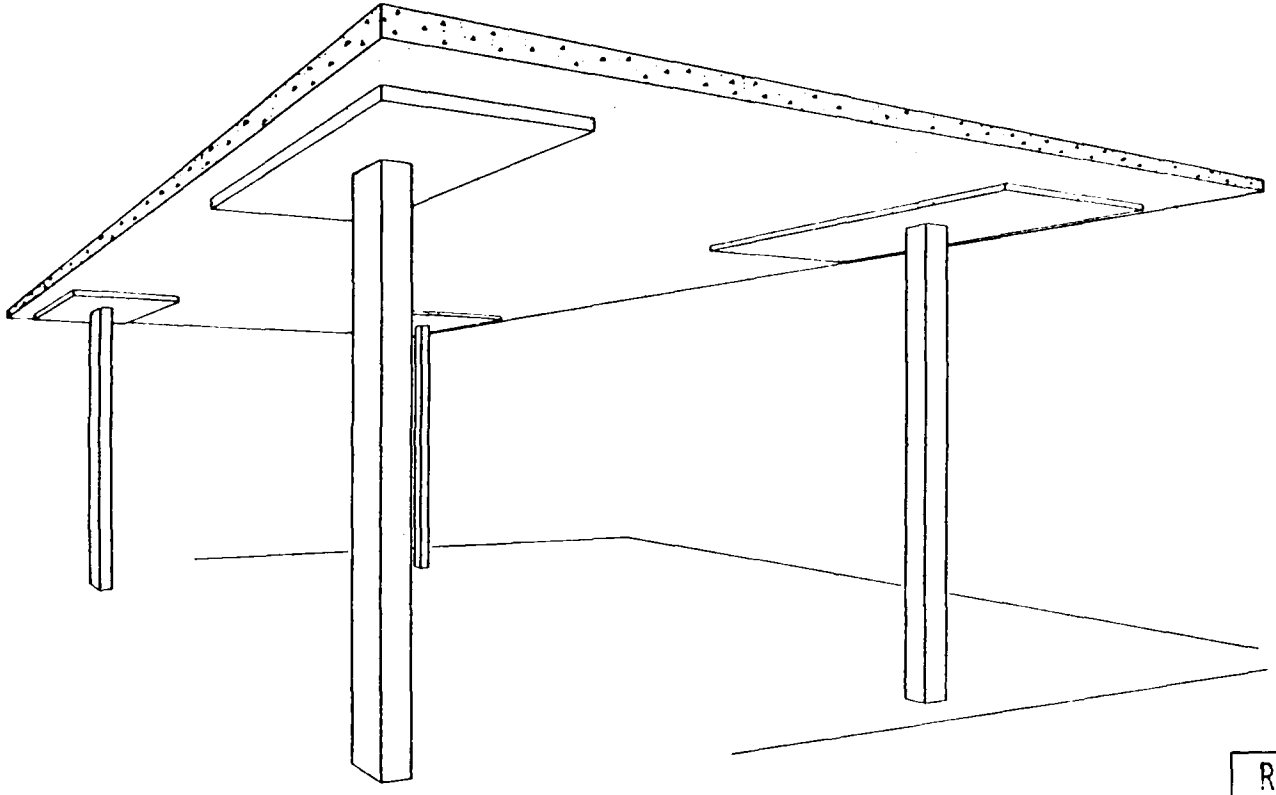
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

FLAT SLAB - HEAVY DESIGN

SUPERIMPOSED DESIGN LOAD-150 to 250 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
None Required	40	N	VI+	DOES NOT REQUIRE UPGRADING		
	100	0.5	VI+			
	1000	2	VI			



TYPICALLY FOUND IN HEAVY MANUFACTURING BUILDINGS AND STORAGE WAREHOUSES.

SPANS NORMALLY 20 FT TO 30 FT.

SLAB 8 IN. TO 12 IN. THICK.

CONCRETE COLUMNS.

DESIGN CRITERION 150 TO 250 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	N	VI$^+$
100	0.5	VI$^+$
1000	2	VI

CONCRETE CONSTRUCTION–Floors

FLAT SLAB – Heavy Design

AS BUILT

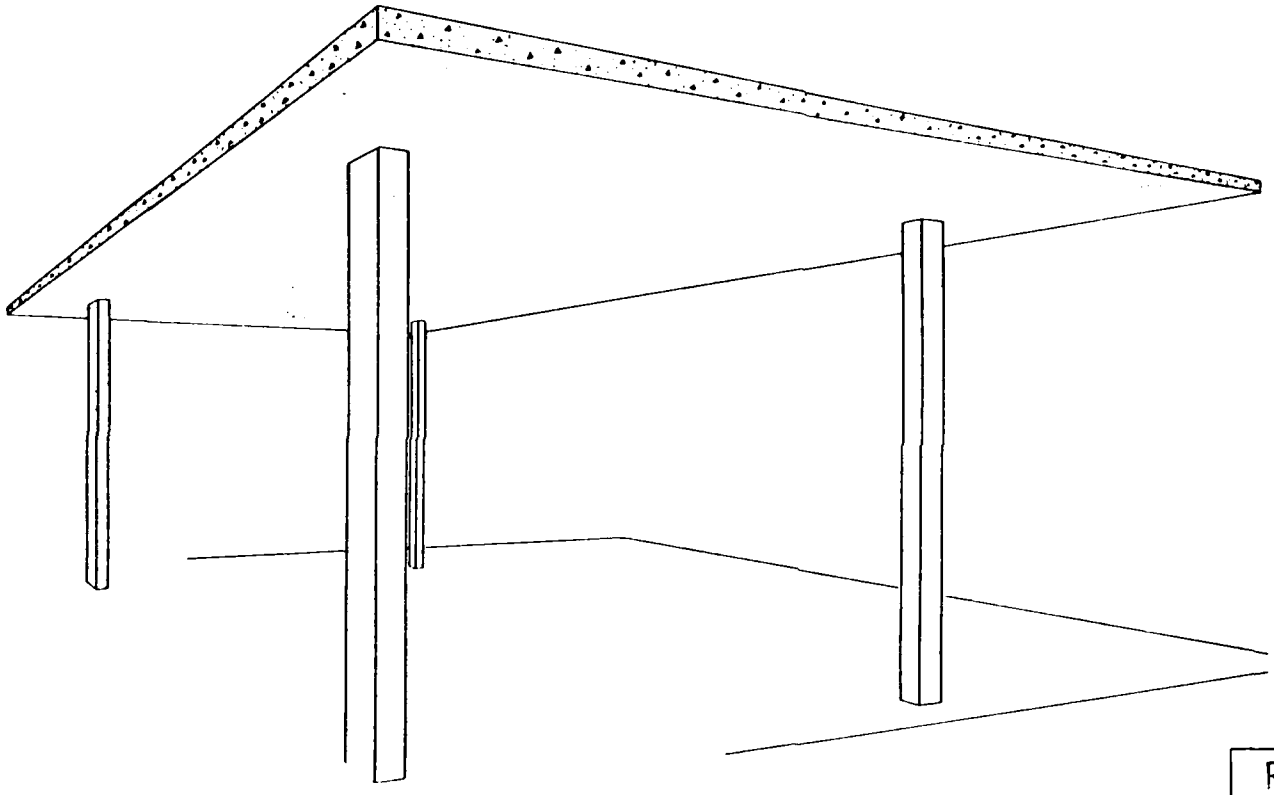
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

FLAT PLATE - HEAVY DESIGN

SUPERIMPOSED DESIGN LOAD-150 to 250 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
None Required	40	N	VI+	DOES NOT REQUIRE UPGRADING		
	100	0.5	VI+			
	1000	2	VI			



TYPICALLY FOUND IN HEAVY MANUFACTURING BUILDINGS AND STORAGE WAREHOUSES.

SPANS NORMALLY 16 FT TO 26 FT.

SLAB 8 IN. TO 10 IN. THICK.

CONCRETE COLUMNS.

DESIGN CRITERION 150 TO 250 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	N	VI$^+$
100	0.5	VI$^+$
1000	2	VI

CONCRETE CONSTRUCTION–Floors

FLAT PLATE – Heavy Design

AS BUILT

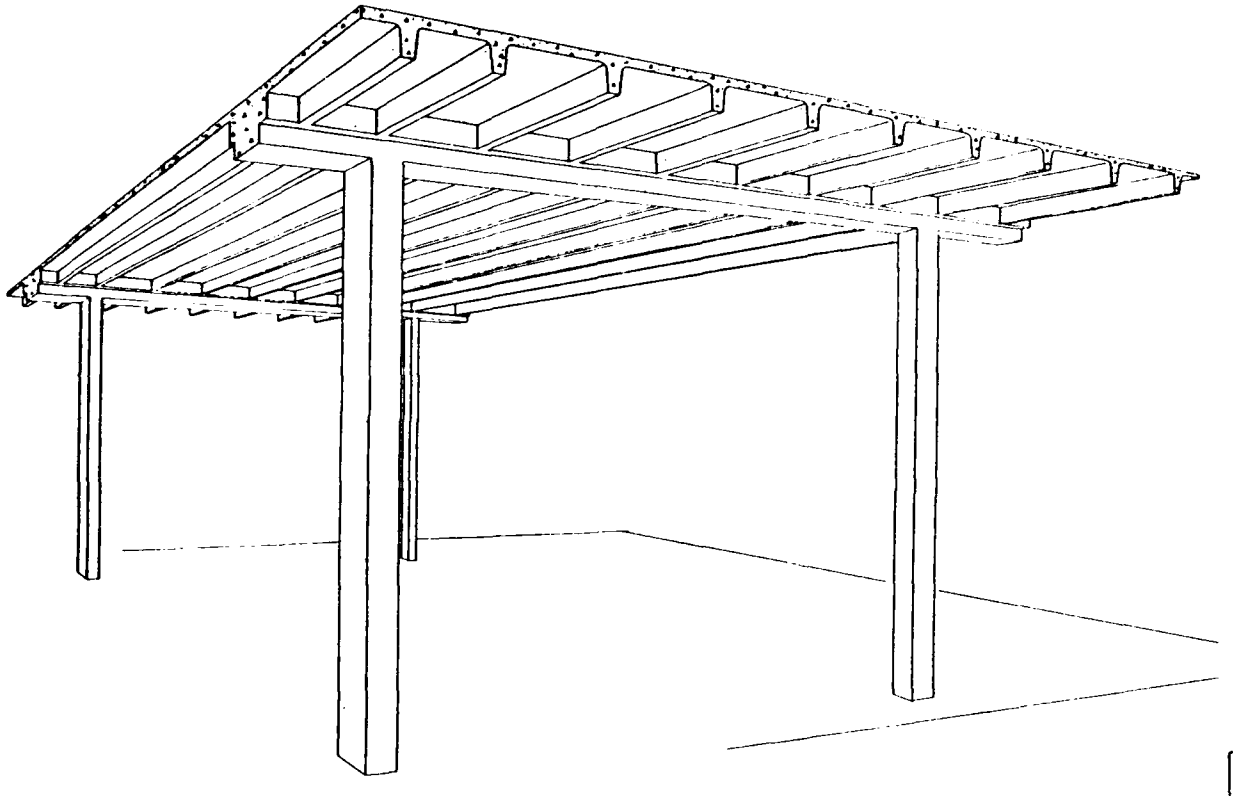
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

ONE-WAY JOIST - HEAVY DESIGN

SUPERIMPOSED DESIGN LOAD-150 to 250 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
None Required	40	0.5	VI+	DOES NOT REQUIRE UPGRADING		
	100	1	VI+			
	1000	2.5	VI			



TYPICALLY FOUND IN HEAVY MANUFACTURING BUILDINGS AND STORAGE WAREHOUSES.

SPANS NORMALLY 16 FT TO 24 FT.

RIBS 10 IN. TO 16 IN. DEEP.

CONCRETE COLUMNS.

DESIGN CRITERION 150 TO 250 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	VI$^+$
100	1	VI$^+$
1000	2.5	VI

CONCRETE CONSTRUCTION–Floors

ONE–WAY JOIST– Heavy Design

AS BUILT

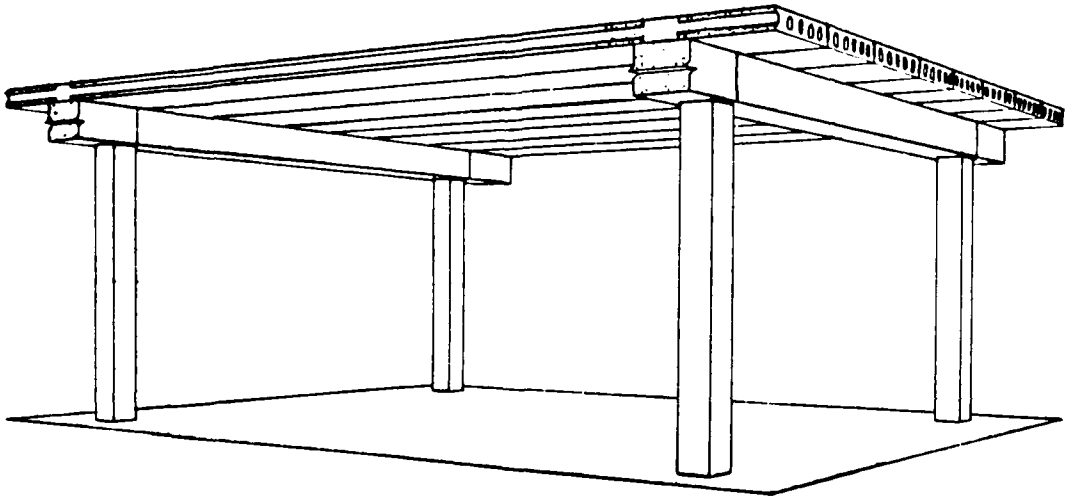
CONCRETE CONSTRUCTION - FLOOR

SURVIVAL RATING VI

HOLLOW-CORE - HEAVY DESIGN

SUPERIMPOSED DESIGN LOAD-150 to 250 PSF

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
None Required	40	0.5	VI+	DOES NOT REQUIRE UPGRADING		
	100	1	VI+			
	1000	2.5	VI			



TYPICALLY FOUND IN HEAVY MANUFACTURING BUILDINGS AND STORAGE WAREHOUSES.

SPANS NORMALLY 18 FT TO 28 FT.

SLAB 8 IN. TO 10 IN. THICK.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DESIGN CRITERION 150 TO 250 PSF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	VI$^+$
100	1	VI$^+$
1000	2.5	VI

CONCRETE CONSTRUCTION–Floors

HOLLOW–CORE – Heavy Design

AS BUILT

SECTION 5

ROOFS

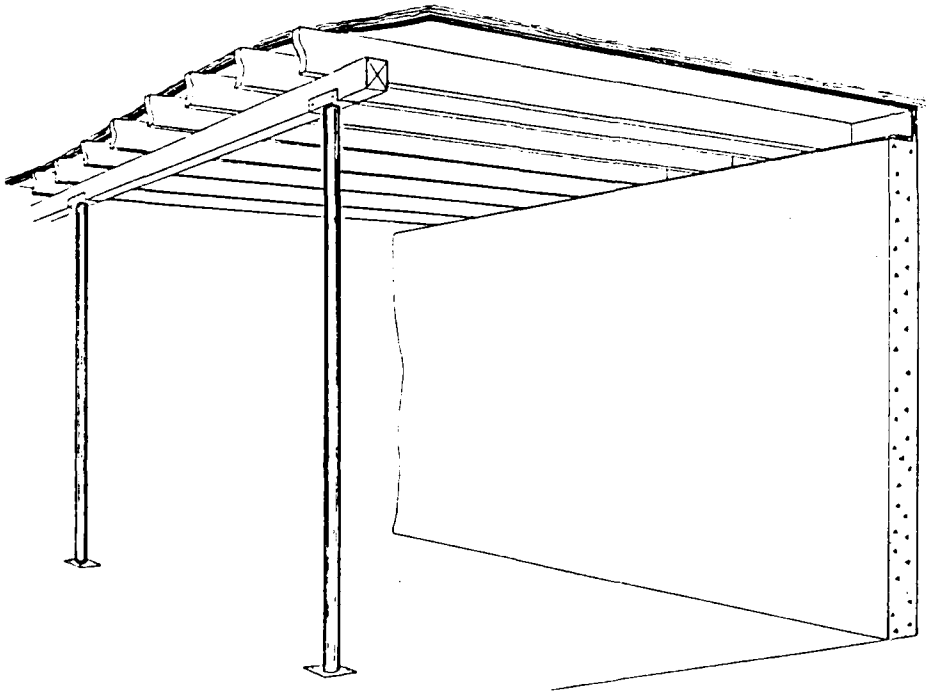
INDEX

WOOD CONSTRUCTION - ROOFS

SURVIVAL RATING VI

TIMBER JOIST

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Two rows of Wood Stud Walls, one each at 1/3 span	40 100 1000	1 1.5 3	VI^+ VI^+ VI^+	Page 6-23	Page 8-1	Page 7-1
Two rows of Post and Beam Shores, one each at 1/3 span	40 100 1000	1 1.5 3	VI^+ VI^+ VI^+	Page 6-24	Page 8-2, 8-3	Page 7-2



SPANS NORMALLY 6 FT. TO 24 FT., DEPTH OF JOIST 6 IN. TO 12 IN.

SUPPORTED BEAM CAN BE EITHER STEEL OR WOOD, AND SUPPORT POSTS WOOD OR STEEL PIPE.

DECK TOPPED WITH PLYWOOD, INSULATION, AND BUILT-UP ROOF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	+
100	-	-
1000	-	-

WOOD CONSTRUCTION–Roofs

TIMBER JOIST

AS BUILT

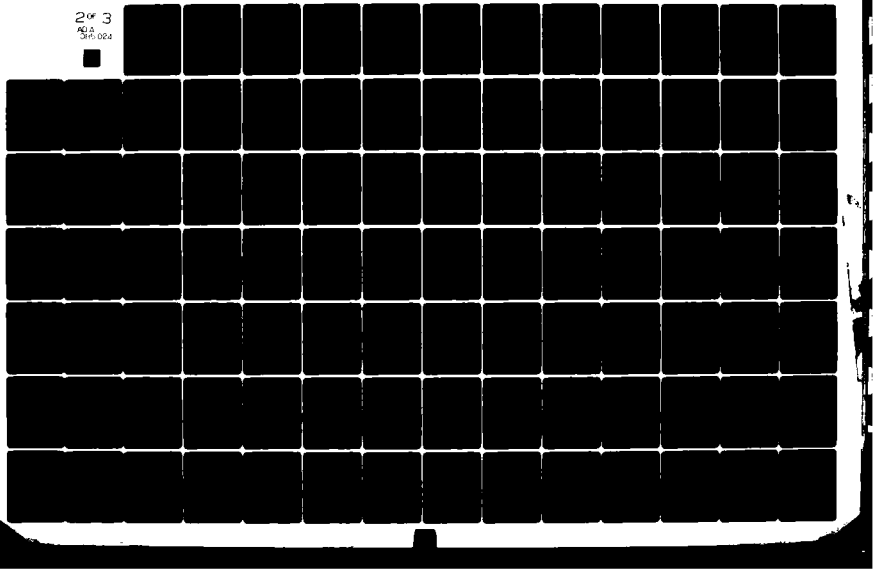
WOOD CONSTRUCTION - ROOFS

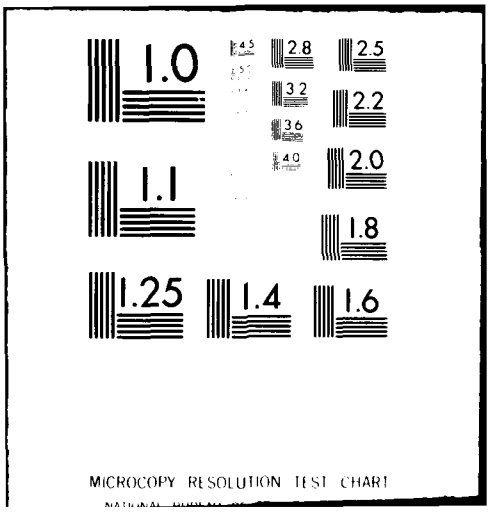
SURVIVAL RATING VI

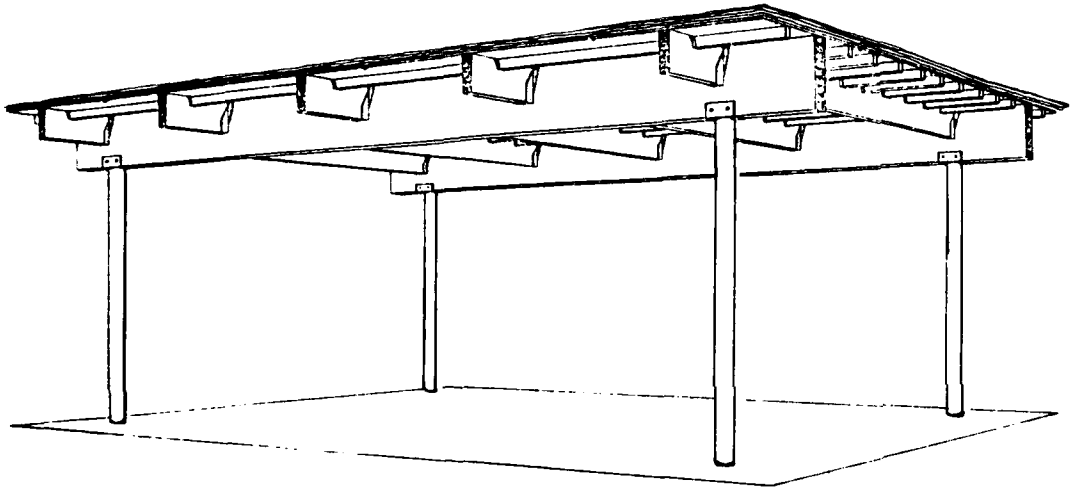
GLULAM

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Two rows of Wood Stud Walls, one each at 1/3 span	40 100 1000	1 1.5 3	VI^+ VI^+ VI^+	Page 6-25	Page 8-1	Page 7-1
Two rows of Post and Beam Shores, one each at 1/3 span	40 100 1000	1 1.5 3	VI^+ VI^+ VI^+	Page 6-26	Page 8-2, 8-3	Page 7-2

AD-A085 024 SCIENTIFIC SERVICE INC REDWOOD CITY CA F/G 13/13
SHELTER UPGRADING MANUAL: HOST AREA SHELTERS.(U)
MAR 80 C WILTON, B L GABRIELSEN, R S TANSLEY DCPA01-78-C-0215
UNCLASSIFIED SSI-7815-8 NL




1.0
2.8
2.5
3.2
2.2
3.6
2.0
4.0
1.1
1.8
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART



SPANS NORMALLY 6 FT. TO 24 FT., DEPTH OF GLULAM JOIST 4 IN. TO 8 IN., SUPPORTED ON GLULAM BEAM, NORMALLY 8 IN. TO 16 IN. DEEP.

SUPPORT POSTS WOOD OR STEEL PIPE.

DECK TOPPED WITH PLYWOOD, INSULATION, AND BUILT-UP ROOF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	†
100	-	-
1000	-	-

WOOD CONSTRUCTION–Roofs

GLULAM

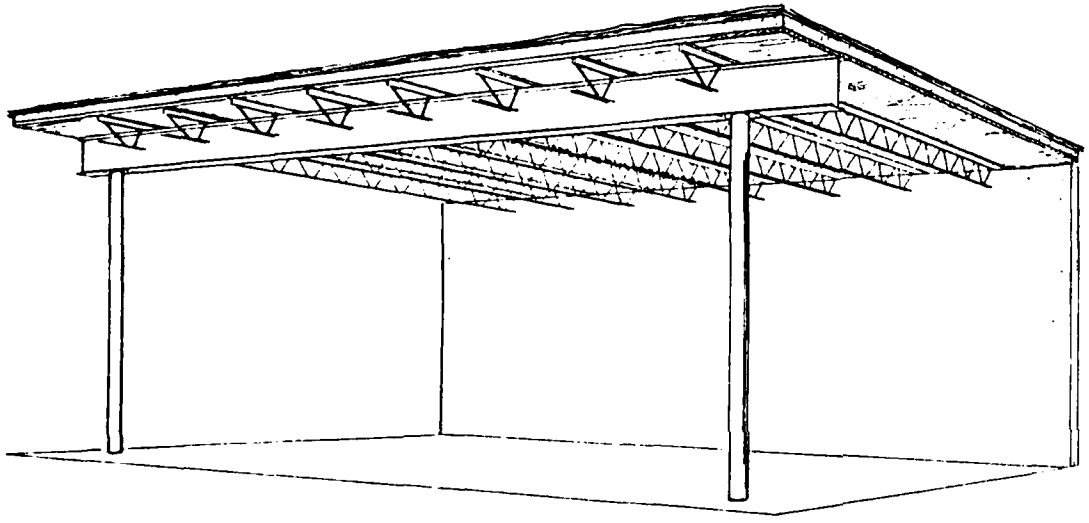
AS BUILT

STEEL - LIGHT CONSTRUCTION - ROOFS

SURVIVAL RATING VI

OPEN-WEB JOIST W/TIMBER DECK, INSULATION

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Two rows of Wood Stud Walls, one each at 1/3 span	40 100 1000	1 1.5 3	VI^+ VI^- 0	Page 6-27	Page 8-1	Page 7-1
Two rows of Post and Beam Shores, one each at 1/3 span	40 100 1000	1 1.5 3	VI^+ VI^- 0	Page 6-28	Page 8-2, 8-3	Page 7-2



SPANS NORMALLY 8 FT TO 24 FT.
OPEN-WEB JOIST DEPTH 8 IN. TO 12 IN.

SUPPORT BEAM NORMALLY STEEL.

DECK TOPPED WITH PLYWOOD, INSULATION AND BUILT-UP ROOF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	+
100	-	-
1000	-	-

STEEL LIGHT CONSTRUCTION–Roofs

OPEN-WEB JOIST

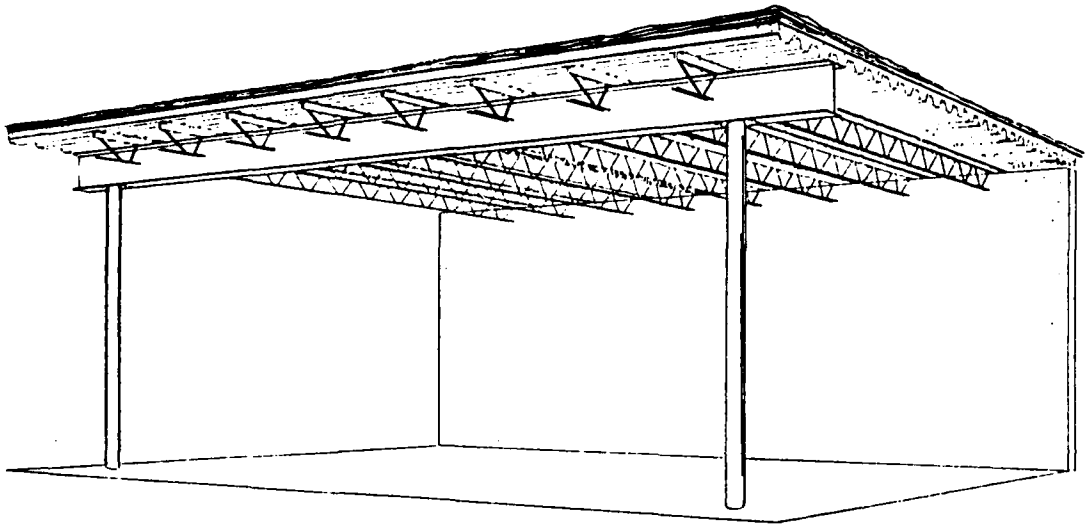
AS BUILT

STEEL - HEAVY CONSTRUCTION - ROOFS

SURVIVAL RATING VI

OPEN-WEB JOIST W/METAL DECK, INSULATION

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Two rows of Wood Stud Walls, one each at 1/3 span	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-29	Page 8-1	Page 7-1
Two rows of Post and Beam Shores, one each at 1/3 span	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-30	Page 8-2, 8-3	Page 7-2



SPANS NORMALLY 16 FT TO 30 FT.

OPEN-WEB JOIST DEPTH 8 IN. TO 16 IN.

SUPPORT BEAM NORMALLY STEEL.

DECK TOPPED WITH METAL DECK, INSULATION, AND BUILT-UP ROOF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	†
100	-	-
1000	-	-

STEEL HEAVY CONSTRUCTION–Roofs

OPEN-WEB JOIST

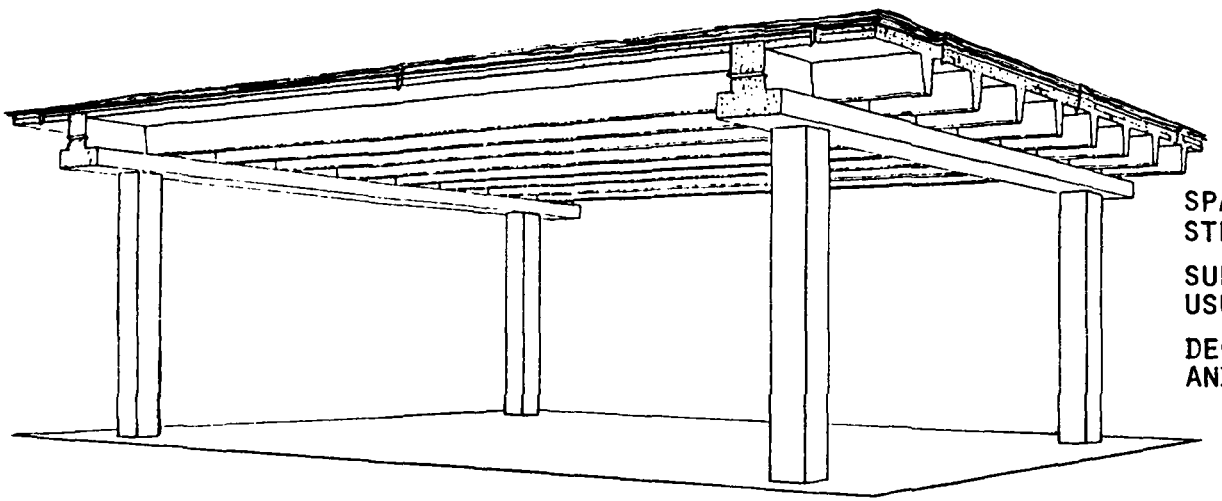
AS BUILT

CONCRETE CONSTRUCTION - ROOFS

SURVIVAL RATING VI

DOUBLE TEES

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40 100 1000	1 1.5 3	VI^+ VI 0	Page 6-31	Page 8-1	Page 7-1
Post and Beam Shores at Mid-span	40 100 1000	1 1.5 3	VI^+ VI 0	Page 6-32	Page 8-2, 8-3	Page 7-2



SPANS NORMALLY 16 FT TO 40 FT.
STEMS 8 IN. TO 24 IN. DEEP.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DECK TOPPED WITH INSULATION AND BUILT-UP ROOF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	+
1000	-	-

CONCRETE CONSTRUCTION–Roofs
DOUBLE TEE

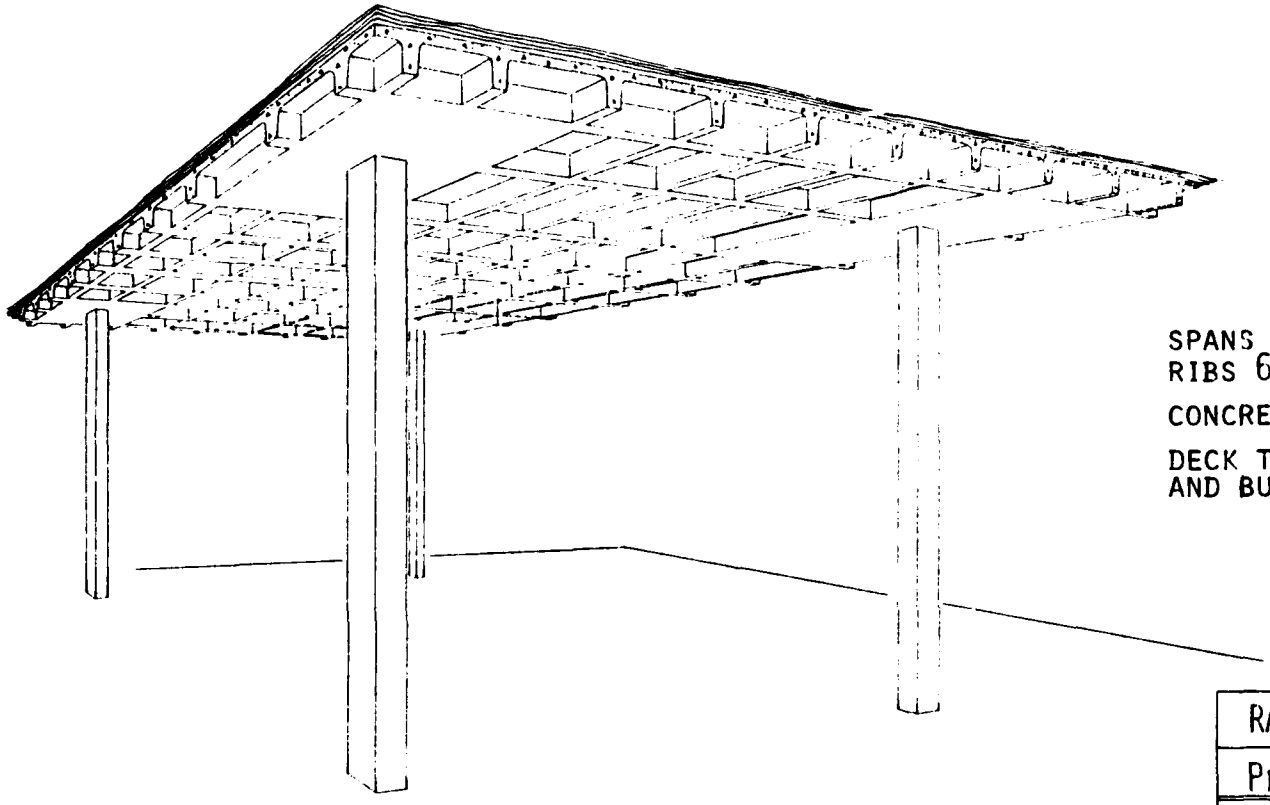
AS BUILT

CONCRETE CONSTRUCTION - ROOFS

SURVIVAL RATING VI

WAFFLE SLAB

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Post Shores at Midspan	40	1	VI+	Page 6-33	Page 8-4	Page 7-6
	100	1.5	VI			
	1000	3	0			



SPANS NORMALLY 16 FT TO 30 FT.
RIBS 6 IN. TO 10 IN. DEEP.

CONCRETE COLUMNS.

DECK TOPPED WITH INSULATION AND BUILT-UP ROOF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	+
1000	-	-

CONCRETE CONSTRUCTION–Roofs

WAFFLE SLAB

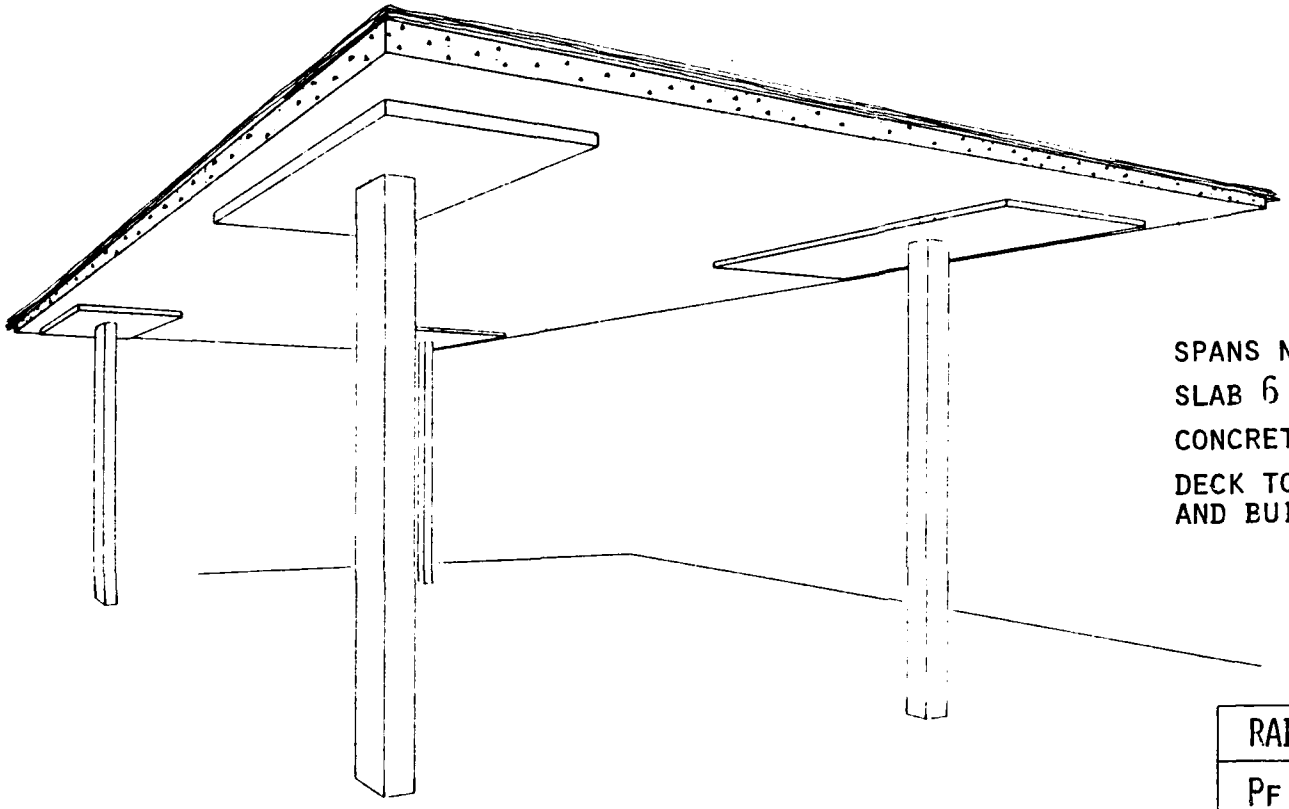
AS BUILT

CONCRETE CONSTRUCTION - ROOFS

SURVIVAL RATING VI

FLAT SLAB

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Post Shores at Midspan	40	0.5	VI+	Page 6-34	Page 8-4	Page 7-6
	100	1	VI			
	1000	2.5	0			



SPANS NORMALLY 16 FT TO 30 FT.
SLAB 6 IN. TO 10 IN. THICK.
CONCRETE COLUMNS.
DECK TOPPED WITH INSULATION AND BUILT-UP ROOF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	0
100	1	0
1000	2.5	+

CONCRETE CONSTRUCTION–Roofs

FLAT SLAB

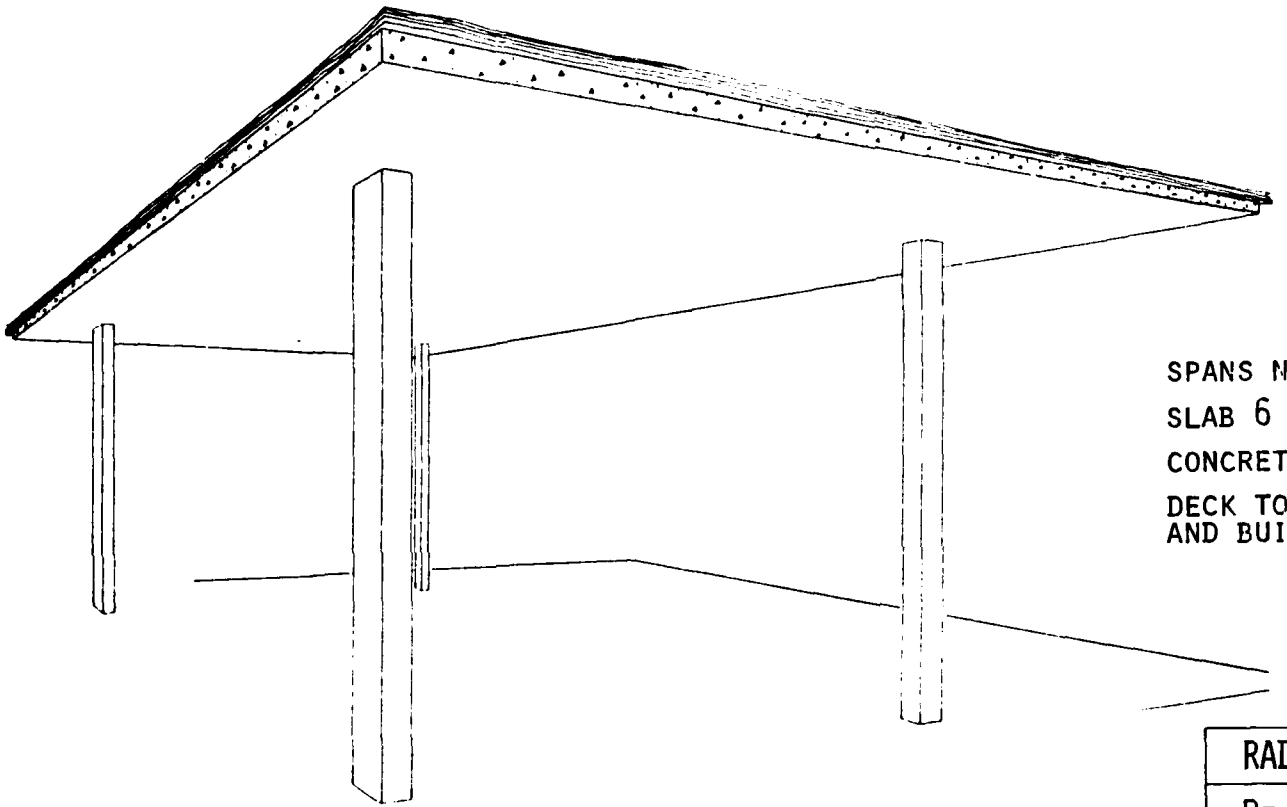
AS BUILT

CONCRETE CONSTRUCTION - ROOFS

SURVIVAL RATING VI

FLAT PLATE

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Post Shores at Midspan	40	0.5	VI$^+$	Page 6-35	Page 8-4	Page 7-6
	100	1	VI			
	1000	2.5	0			



SPANS NORMALLY 16 FT TO 30 FT.

SLAB 6 IN. TO 10 IN.

CONCRETE COLUMNS.

DECK TOPPED WITH INSULATION AND BUILT-UP ROOF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	0.5	0
100	1	0
1000	2.5	†

CONCRETE CONSTRUCTION–Roofs

FLAT PLATE

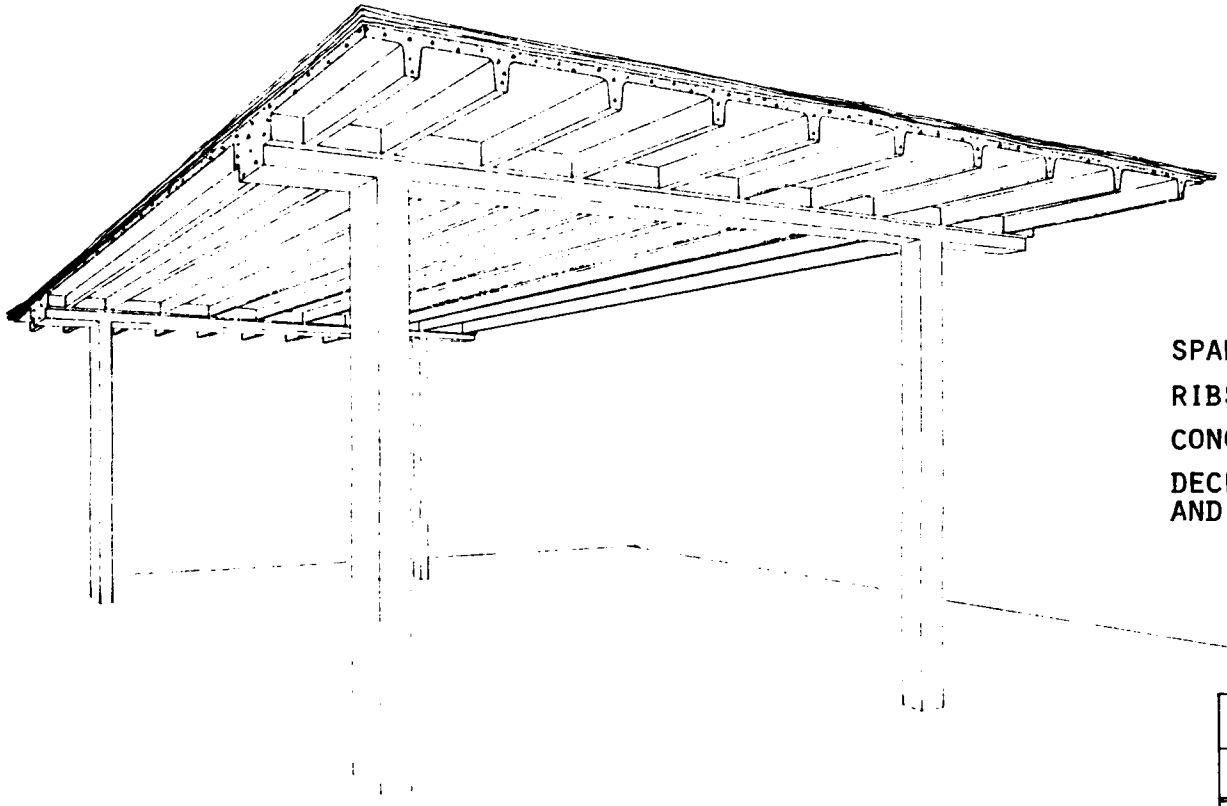
AS BUILT

CONCRETE CONSTRUCTION - ROOFS

SURVIVAL RATING VI

ONE-WAY JOIST

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-36	Page 8-1	Page 7-1
Post and Beam Shores at Mid-span	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-37	Page 8-2, 8-3	Page 7-2



SPANS NORMALLY 16 FT TO 35 FT.
RIBS 8 IN. TO 14 IN. DEEP
CONCRETE COLUMNS.
DECK TOPPED WITH INSULATION AND BUILT-UP ROOF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	†
1000	-	-

CONCRETE CONSTRUCTION–Roofs

ONE-WAY JOIST

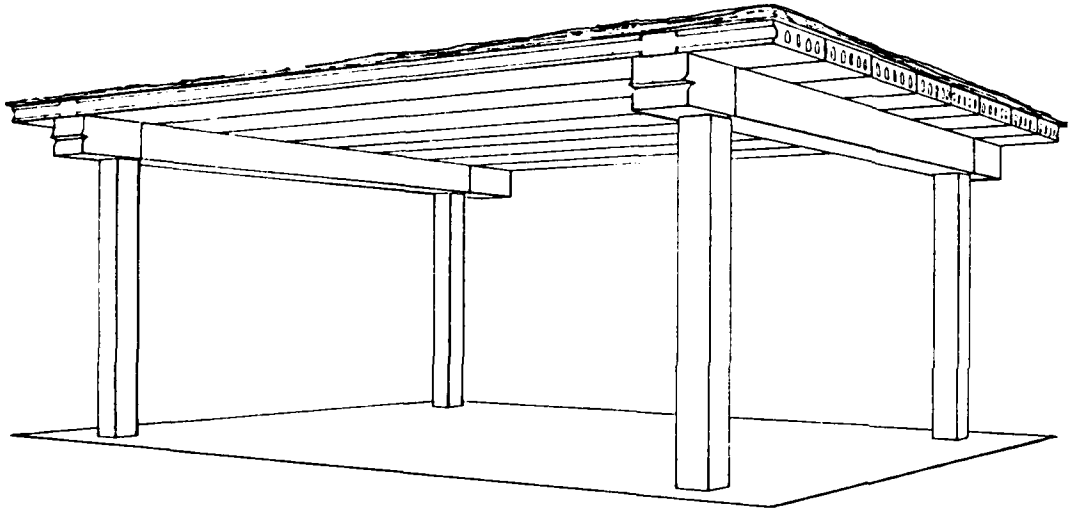
AS BUILT

CONCRETE CONSTRUCTION - ROOFS

SURVIVAL RATING VI

HOLLOW-CORE

SHORING SYSTEM REQUIRED	P_f	KEY	S_R	ILLUSTRATION AND DETAILS-Sect. 6	CHARTS FOR SIZE AND SPACING OF SHORES Sect. 8	WORKSHEETS Sect. 7
Wood Stud Wall at Midspan	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-38	Page 8-1	Page 7-1
Post and Beam Shores at Mid-span	40 100 1000	1 1.5 3	VI+ VI 0	Page 6-39	Page 8-2, 8-3	Page 7-2



SPANS NORMALLY 15 FT TO 40 FT.

SLAB 4 IN. TO 10 IN. THICK.

SUPPORT BEAMS AND COLUMNS USUALLY CONCRETE.

DECK TOPPED WITH INSULATION AND BUILT-UP ROOF.

RADIATION		SURVIVAL RATING
P_F	KEY	
40	1	0
100	1.5	+
1000	-	-

CONCRETE CONSTRUCTION–Roofs

HOLLOW–CORE

AS BUILT

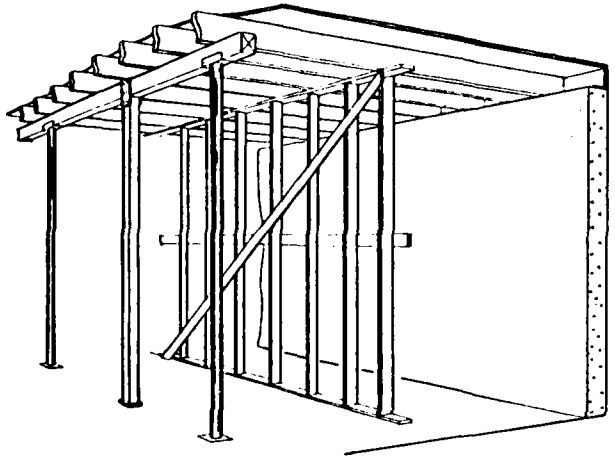
SECTION 6

ILLUSTRATIONS

INDEX

RESOURCE LIST

Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		



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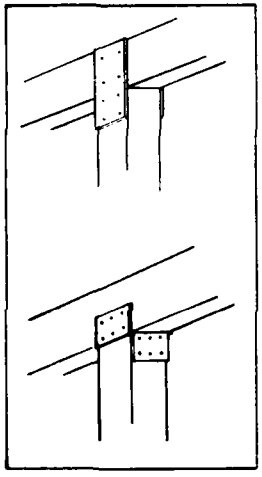
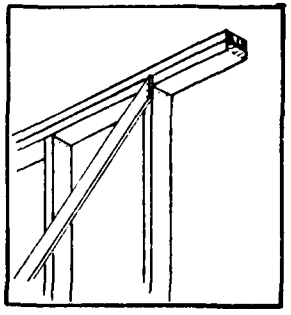
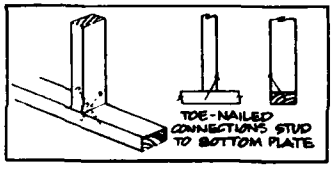
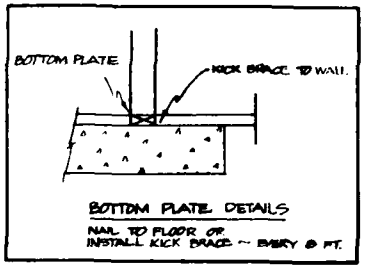


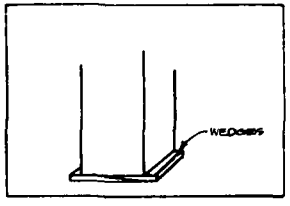






NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x w	6d, 8d
2 x w	8d, 10d, 12d
3 x w	16d, 20d, 30d
4 x w	40d, 50d, 60d

* where w = width of boards
when w = 2 in. use 2 nails
when w = 4 in. use 3 nails
when w = 6 in. use 4 nails



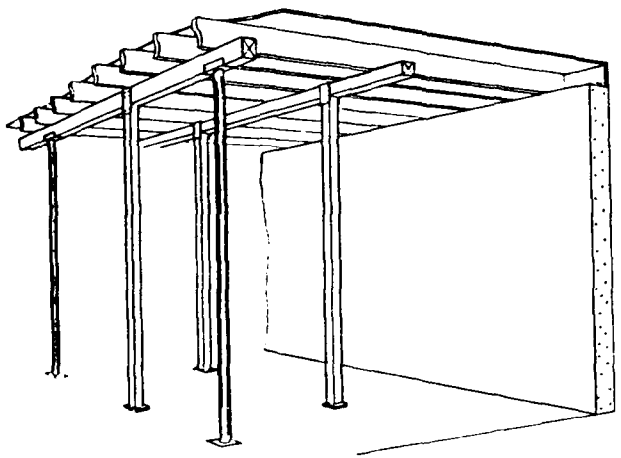
WOOD CONSTRUCTION–Floors

TIMBER JOIST

stud wall upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Posts)		
2. Timber (Beams)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		



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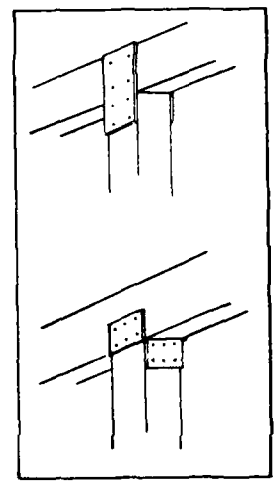
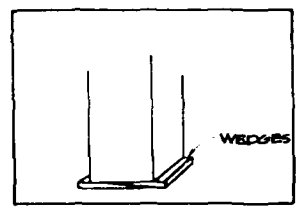


NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x 10	6d, 8d
2 x 10	8d, 10d, 12d
3 x 10	16d, 20d, 30d
4 x 10	40d, 50d, 60d

* where b = width of boards
when b = 2 in. use 2 nails
when b = 4 in. use 3 nails
when b = 6 in. use 4 nails



WOOD CONSTRUCTION–Floors

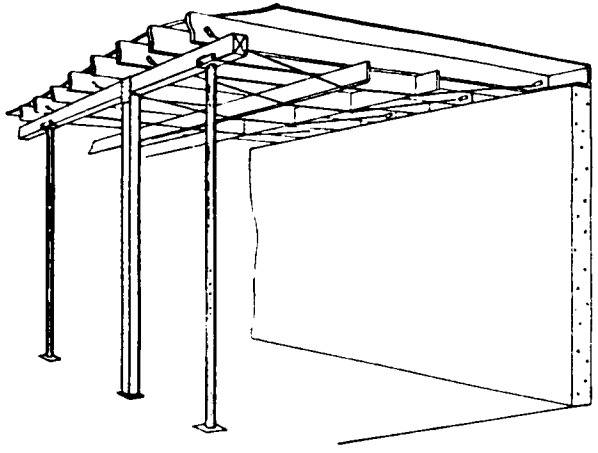
TIMBER JOIST

post & beam upgrading

KING POST TRUSS

RESOURCE LIST

Required	Quantity	Available
1. Timber		
2. Cable or Rods		
3. Connections		
4. Nails		
5. Hammer		
6. Saw		
7. Wedges		
8. Tape measure/yardstick, etc.		
9. _____		
10. _____		



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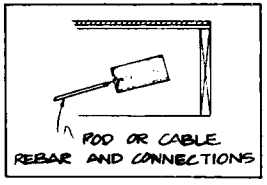
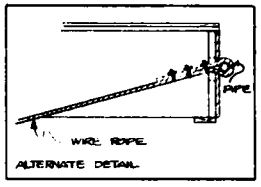
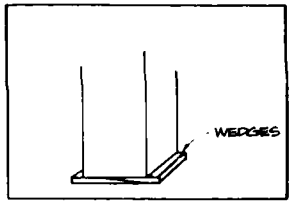
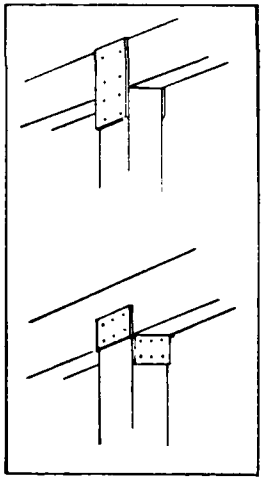








NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x b	6d, 8d
2 x b	8d, 10d, 12d
3 x b	16d, 20d, 30d
4 x b	40d, 50d, 60d

* where b = width of boards
when b = 2 in. use 2 nails
when b = 4 in. use 3 nails
when b = 6 in. use 4 nails

WOOD CONSTRUCTION–Floors

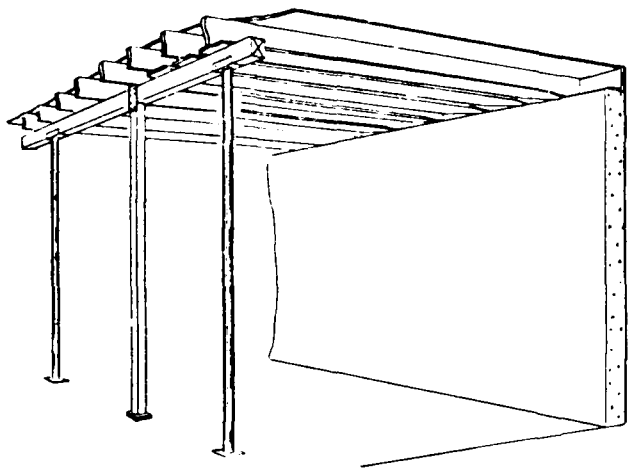
TIMBER JOIST

king post truss upgrading

FLANGE

RESOURCE LIST

	Required	Quantity	Available
1.	Timber		
2.	Glue		
3.	Nails		
4.	Hammer		
5.	Saw		
6.	Wedges		
7.	Tape measure/yardstick, etc.		
8.			
9.			
10.			



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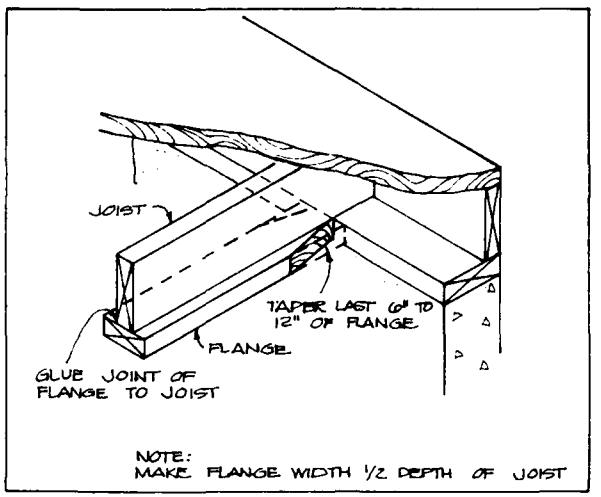
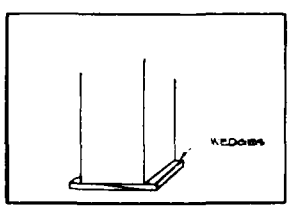
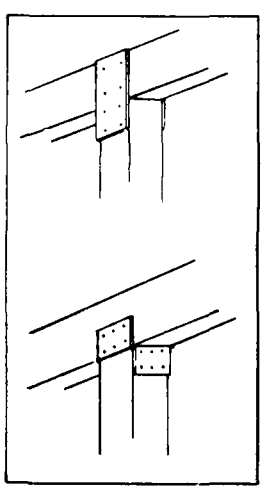




NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x b	6d, 8d
2 x b	8d, 10d, 12d
3 x b	16d, 20d, 30d
4 x b	40d, 50d, 60d

* where b = width of joists
when b = 2 in. use 2 nails
when b = 4 in. use 3 nails
when b = 6 in. use 4 nails



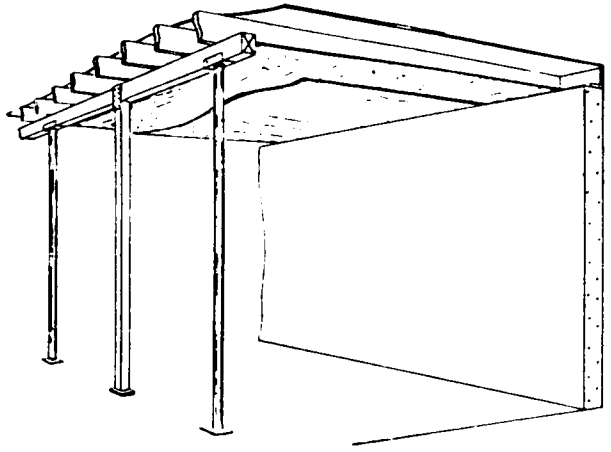
WOOD CONSTRUCTION–Floors

TIMBER JOIST

flange upgrading

RESOURCE LIST

Required	Quantity	Available
1. Plywood		
2. Glue		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		



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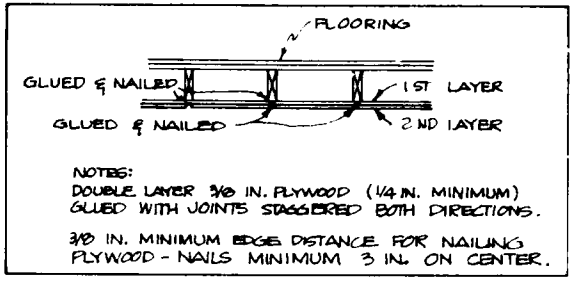
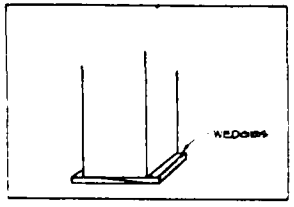


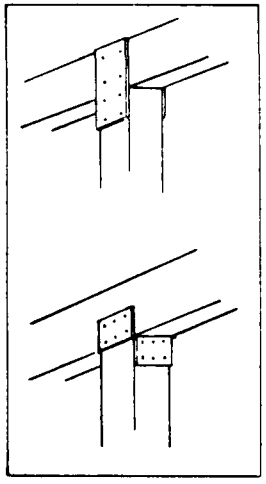
NOTES:
DOUBLE LAYER 3/8 IN. PLYWOOD (1/4 IN. MINIMUM)
GLUED WITH JOINTS STAGGERED BOTH DIRECTIONS.

3/8 IN. MINIMUM EDGE DISTANCE FOR NAILING
PLYWOOD - NAILS MINIMUM 3 IN. ON CENTER.



NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x 10	6d, 8d
2 x 10	8d, 10d, 12d
3 x 10	16d, 20d, 30d
4 x 10	40d, 50d, 60d

* where b = width of joists
when b = 2 in. use 2 nails
when b = 4 in. use 3 nails
when b = 6 in. use 4 nails



WOOD CONSTRUCTION–Floors

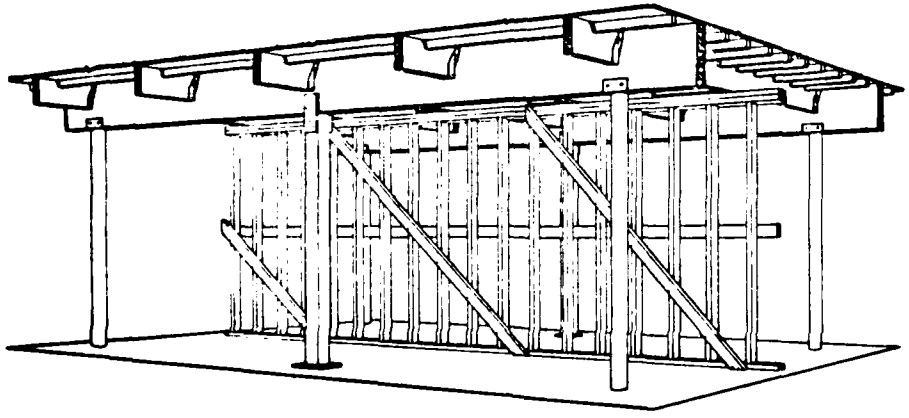
TIMBER JOIST

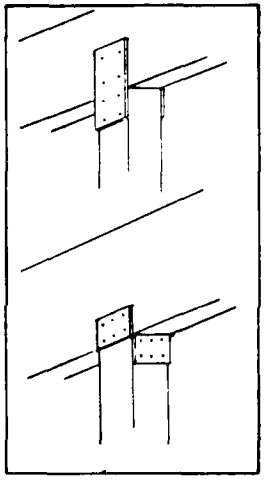
boxed beam upgrading

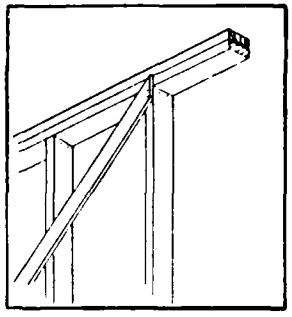
RESOURCE LIST

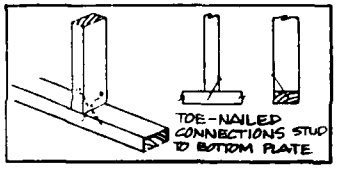
Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		

details



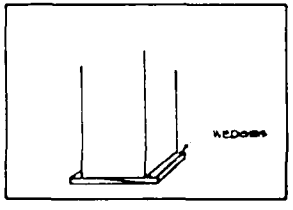


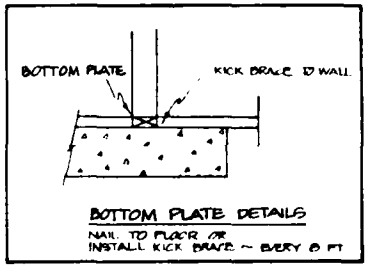




NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x 10	6d, 8d
2 x 10	8d, 10d 12d
3 x 10	16d 20d 30d
4 x 10	40d 50d 60d

* where b = width of boards
when b = 2 in. use 2 nails
when b = 4 in. use 3 nails
when b = 6 in. use 4 nails





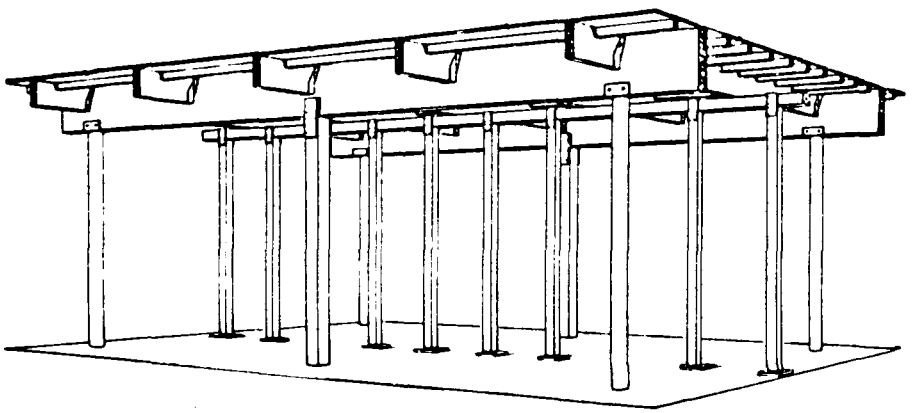
WOOD CONSTRUCTION–Floors

GLULAM

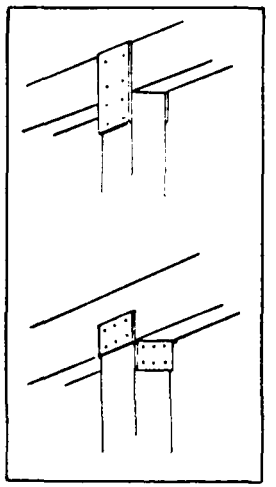
stud wall upgrading

RESOURCE LIST

	Required	Quantity	Available
1.	Timber (Posts)		
2.	Timber (Beams)		
3.	Nails		
4.	Hammer		
5.	Saw		
6.	Wedges		
7.	Tape measure/yardstick, etc.		
8.			
9.			
10.			

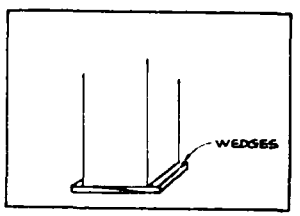


details



NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x b	6d, 8d
2 x b	8d, 10d, 12d
3 x b	16d, 20d, 30d
4 x b	40d, 50d, 60d

* where b = width of boards
when b = 2 in, use 2 nails
when b = 4 in, use 3 nails
when b = 6 in, use 4 nails



WOOD CONSTRUCTION–Floors

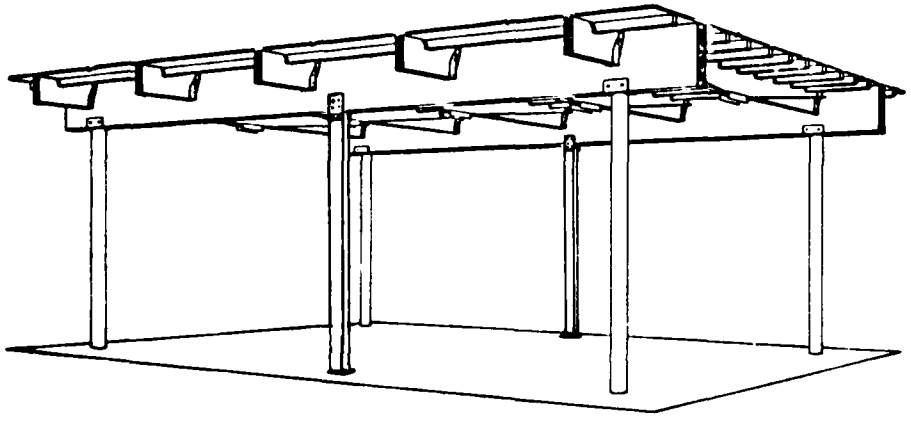
GLULAM

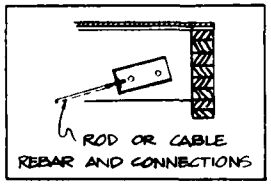
post & beam upgrading

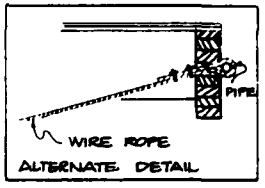
RESOURCE LIST

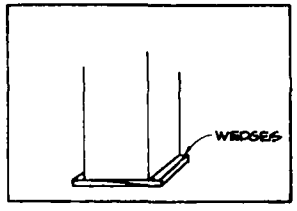
Required	Quantity	Available
1. Timber		
2. Cable or Rods		
3. Connections		
4. Nails		
5. Hammer		
6. Saw		
7. Wedges		
8. Tape measure/yardstick, etc.		
9.		
10.		

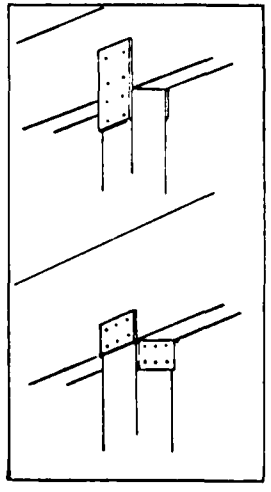
details





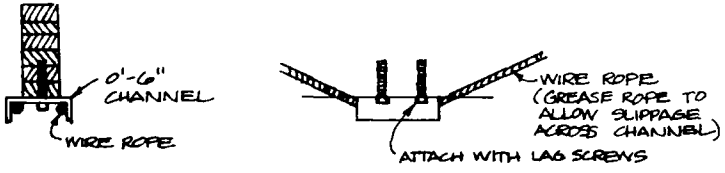






NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x b	6d, 8d
2 x b	8d, 10d, 12d
3 x b	10d, 20d, 30d
4 x b	40d, 50d, 60d

* where b = width of boards
when b = 2 in, use 2 nails
when b = 4 in, use 3 nails
when b = 6 in, use 4 nails



DETAIL AT MIDSPAN

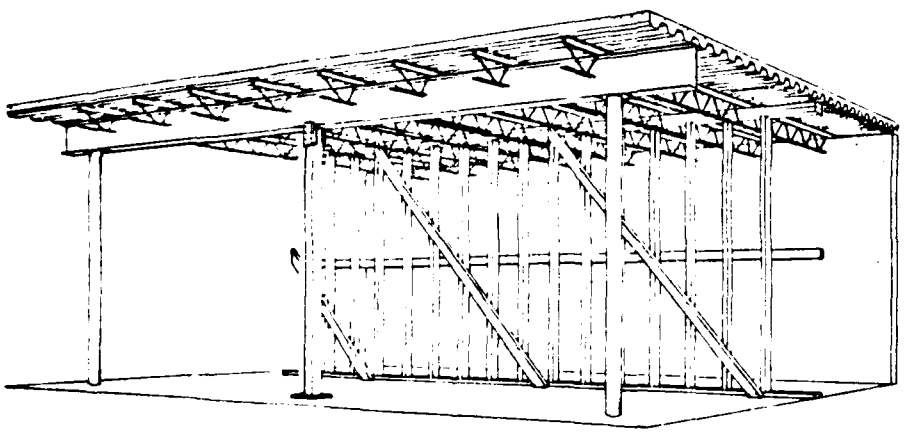
WOOD CONSTRUCTION–Floors

GLULAM

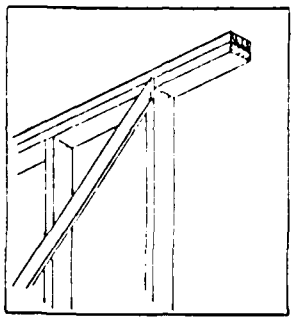
king post truss upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		

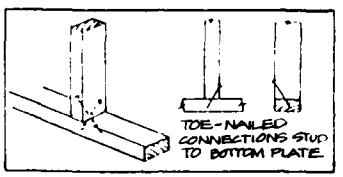


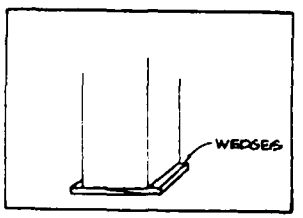
details

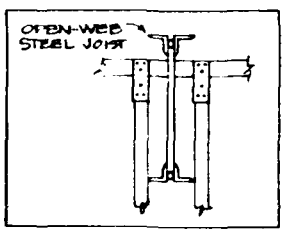


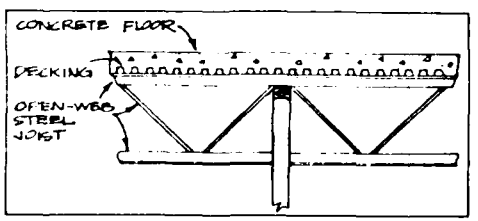
NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x b	6d, 8d
2 x b	8d, 10d, 12d
3 x b	10d, 12d, 16d
4 x b	40d, 50d, 60d

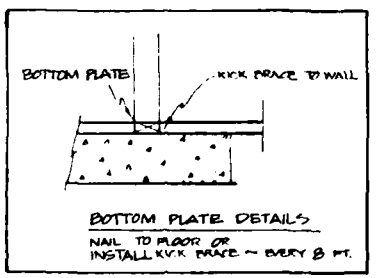
* where b = width of boards
when b = 2", use 2 nails
when b = 3", use 3 nails
when b = 6", use 4 nails

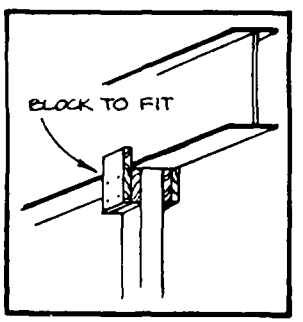












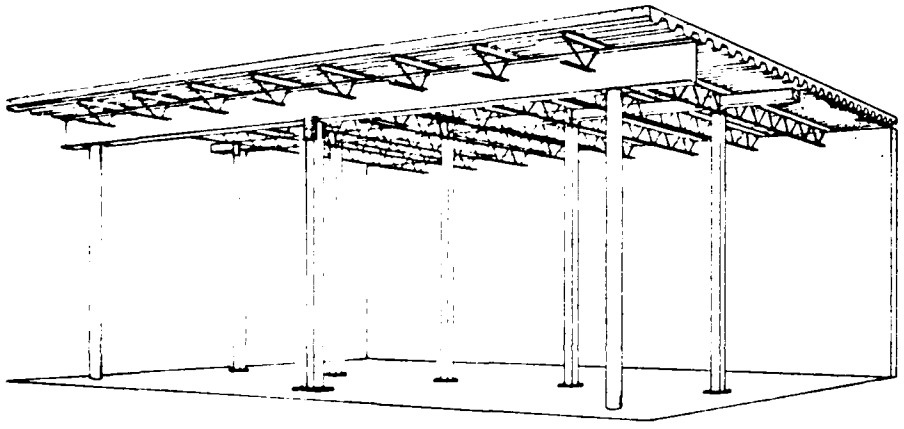
STEEL–LIGHT CONSTRUCTION–Floors

OPEN–WEB JOIST

stud wall upgrading

RESOURCE LIST

	Required	Quantity	Available
1.	Timber (Posts)		
2.	Timber (Beams)		
3.	Nails		
4.	Hammer		
5.	Saw		
6.	Wedges		
7.	Tape measure/yardstick, etc.		
8.			
9.			
10.			



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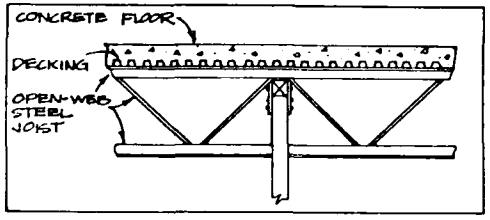
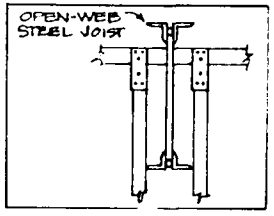
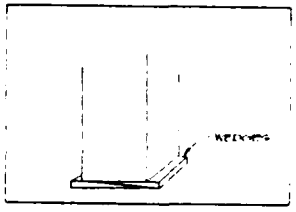
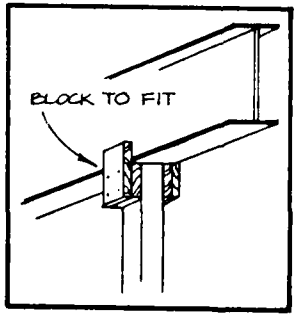


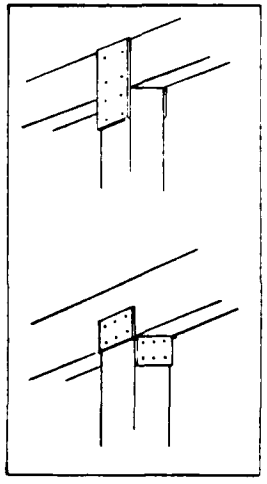






NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x b*	6d, 8d
2 x b*	8d, 10d, 12d
3 x b*	10d, 20d, 30d
4 x b*	40d, 50d, 60d

* where b = width of boards
when b = 2 in. use 2 nails
when b = 4 in. use 3 nails
when b = 6 in. use 4 nails



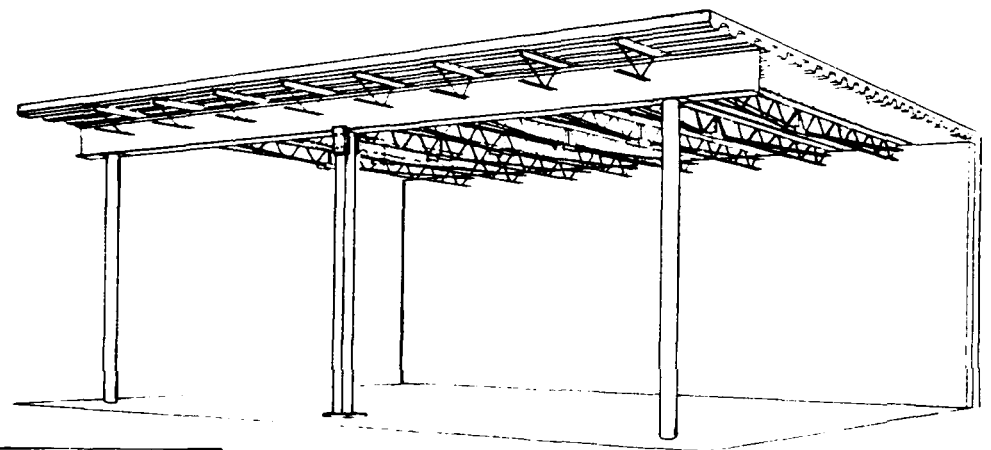
STEEL–LIGHT CONSTRUCTION–Floors

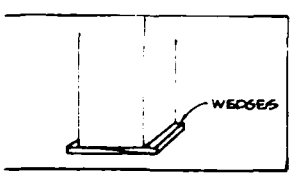
OPEN–WEB JOIST

post & beam upgrading

RESOURCE LIST

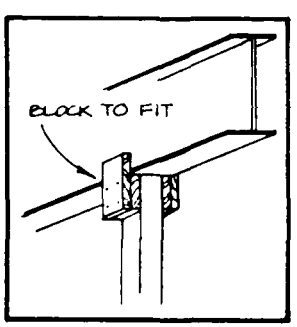
Required	Quantity	Available
1. Timber		
2. Cable or Rods		
3. Connections		
4. Nails		
5. Hammer		
6. Saw		
7. Wedges		
8. Tape measure/yardstick, etc.		
9.		
10.		

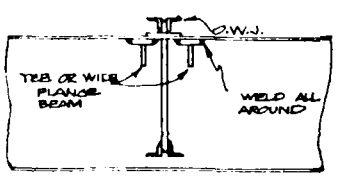


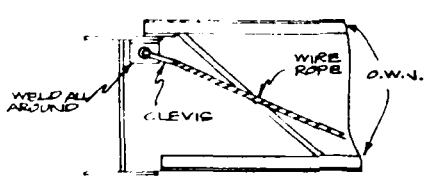


NAILING SCHEDULE	
BOARD SIZE (NOM)	[illegible]
2 x 10	6d, 8d
2 x 10	8d, 10d, 12d
3 x 10	6d, 20d, 30d
4 x 10	40d, 50d, 60d

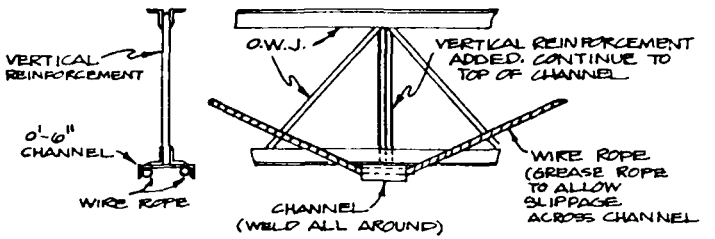
* where D = width of member
when D = 2 in. use 2 nails
when D = 4 in. use 3 nails
when D = 6 in. use 4 nails



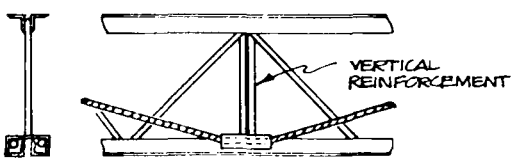




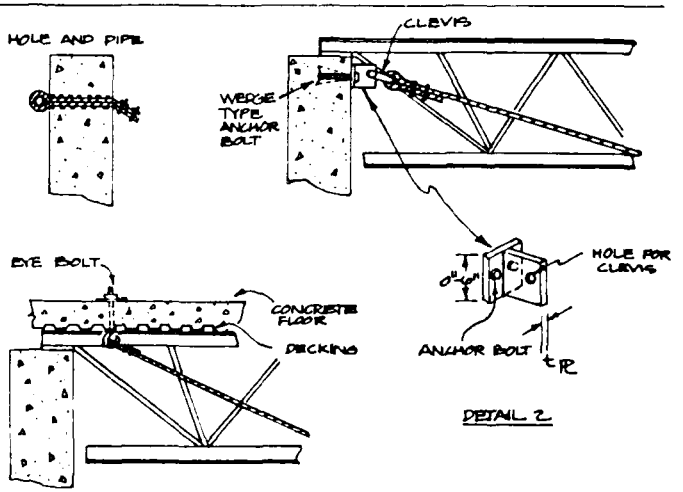
details



DETAIL 1
(PREFERRED ARRANGEMENT)



ALT. DETAIL 1



DETAIL 2

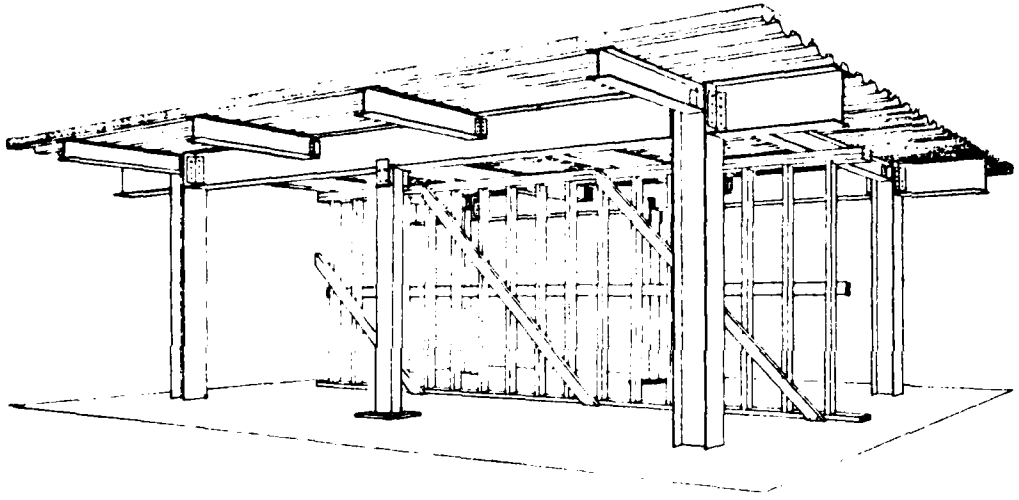
STEEL–LIGHT CONSTRUCTION–Floors

OPEN–WEB JOIST

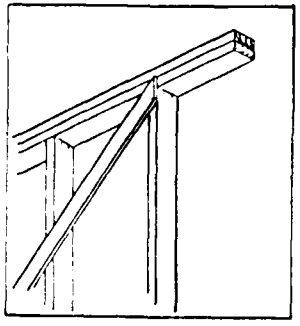
king post truss upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		

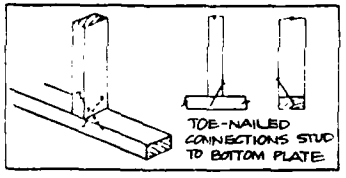


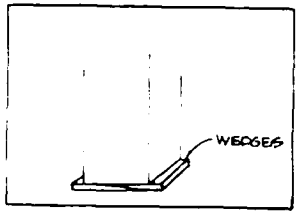
details

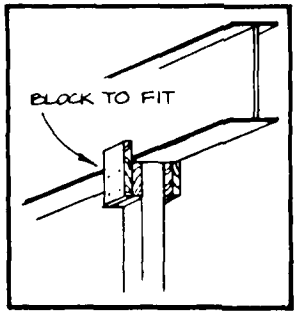


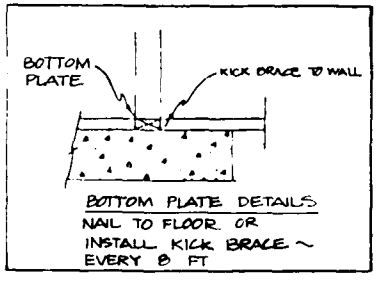
NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x 10	6d, 8d
2 x 10	8d, 10d, 12d
3 x 10	10d, 20d, 30d
4 x 10	40d, 50d, 60d

* where b = width of boards
when b = 2 in. use 2 nails
when b = 4 in. use 3 nails
when b = 6 in. use 4 nails









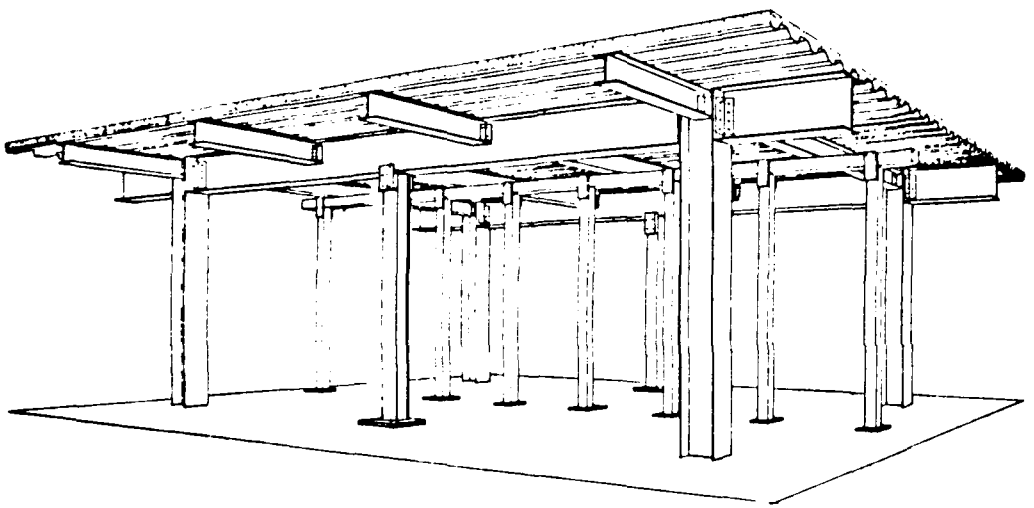
STEEL–HEAVY CONSTRUCTION–Floors

BEAM AND SLAB

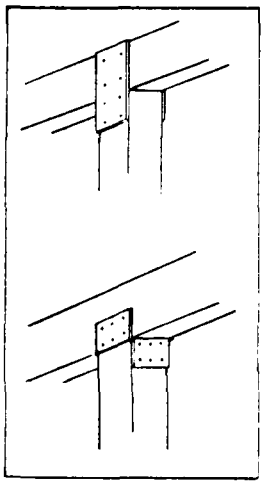
stud wall upgrading

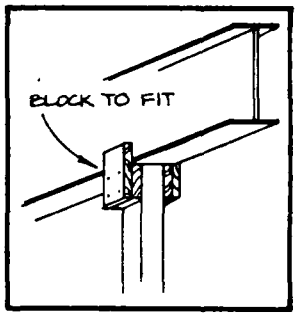
RESOURCE LIST

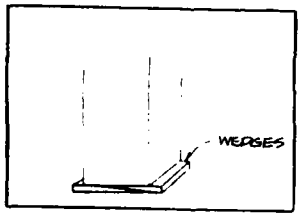
Required	Quantity	Available
1. Timber (Posts)		
2. Timber (Beams)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		



details







NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x b	6d, 8d
2 x b	8d, 10d, 12d
3 x b	16d, 20d, 30d
4 x b	40d, 50d, 60d

* where b = width of boards
when b = 2 in. use 2 nails
when b = 4 in. use 3 nails
when b = 6 in. use 4 nails

STEEL–HEAVY CONSTRUCTION–Floors

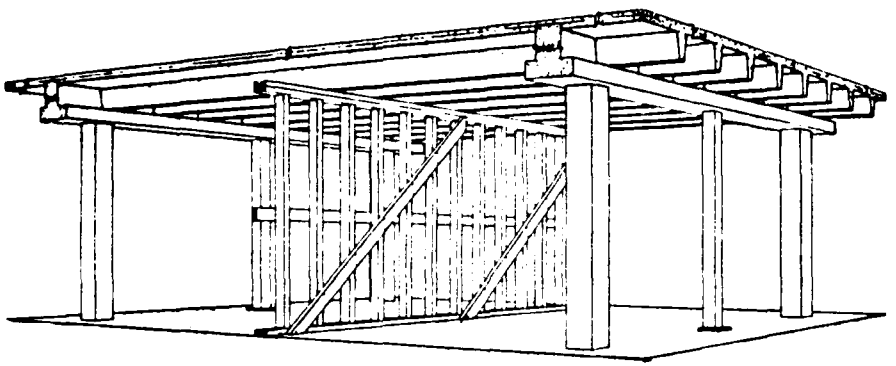
BEAM AND SLAB

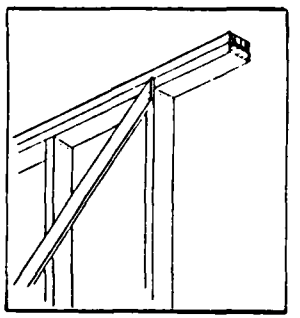
post & beam upgrading

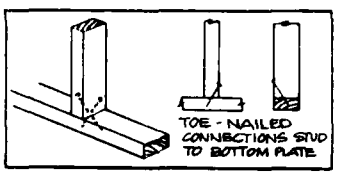
RESOURCE LIST

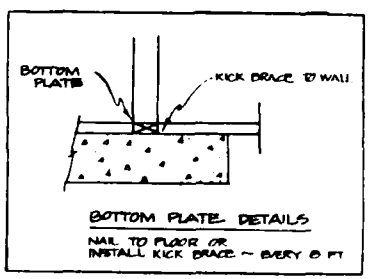
Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		

details



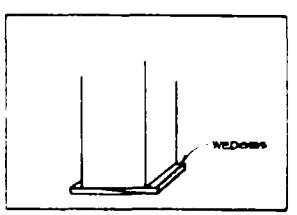






NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x 10	6d, 8d
2 x 10	8d, 10d, 12d
3 x 10	16d, 20d, 30d
4 x 10	40d, 50d, 60d

* where b = width of boards
when b = 2 in. use 2 nails
when b = 4 in. use 3 nails
when b = 6 in. use 4 nails



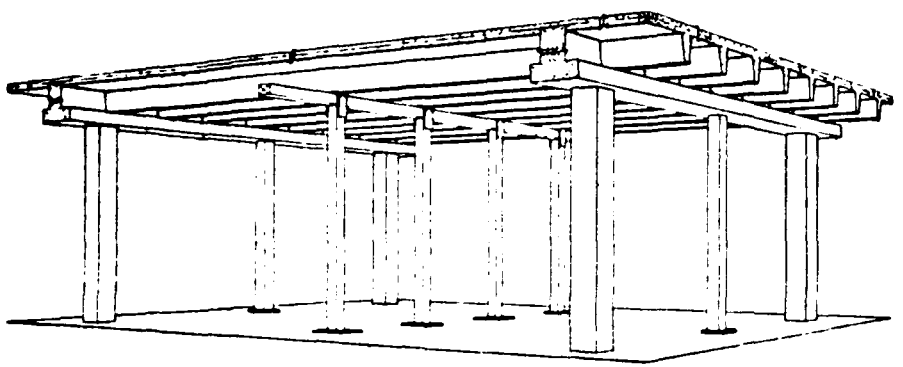
CONCRETE CONSTRUCTION–Floors

DOUBLE TEE

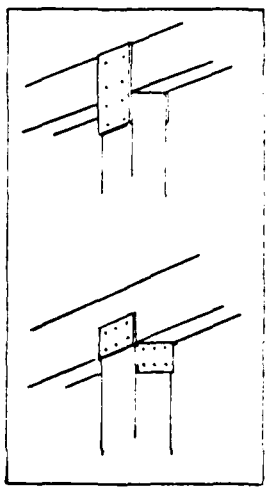
stud wall upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Posts)		
2. Timber (Beams)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		

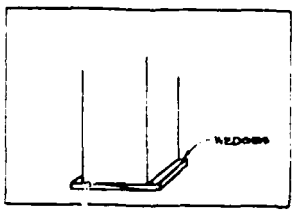


details



NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x b	6d, 8d
2 x b	8d, 10d, 12d
3 x b	16d, 20d, 30d
4 x b	40d, 50d, 60d

* where b = width of beams
when b = 2 in, use 2 nails
when b = 4 in, use 3 nails
when b = 6 in, use 4 nails



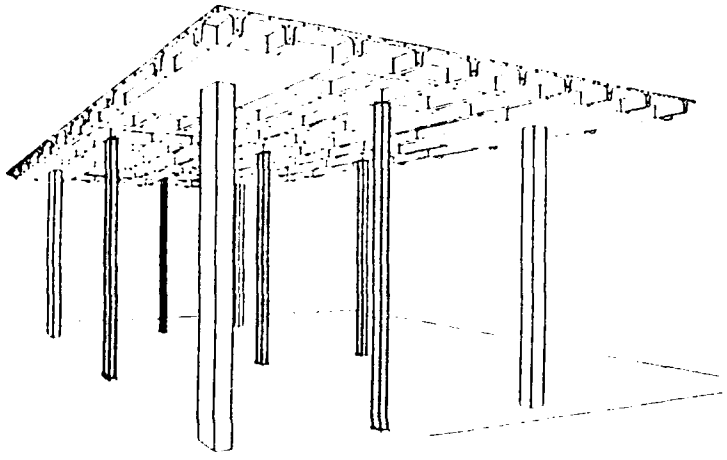
CONCRETE CONSTRUCTION–Floors

DOUBLE TEE

post & beam upgrading

RESOURCE LIST

	Required	Quantity	Available
1.	Timber Posts		
2.	Nails		
3.	Hammer		
4.	Saw		
5.	Wedges		
6.	Tape measure/yardstick, etc.		
7.			
8.			
9.			
10.			



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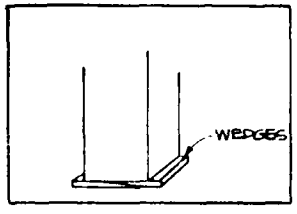


CONCRETE CONSTRUCTION–Floors

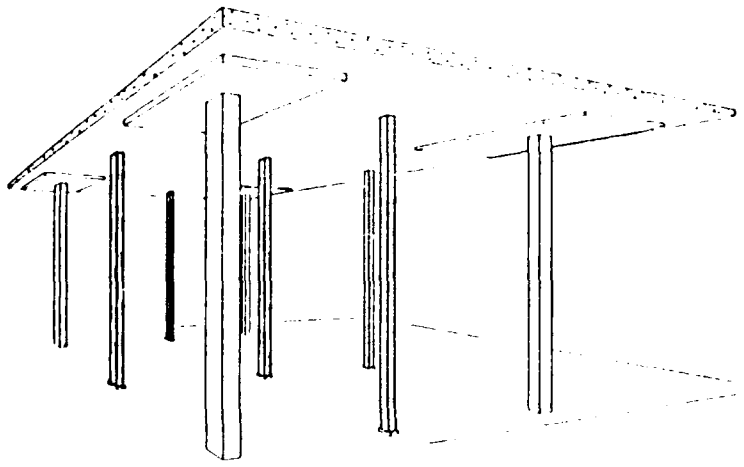
WAFFLE SLAB

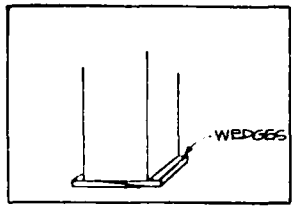
post upgrading

RESOURCE LIST

	Required	Quantity	Available
1.	Timber Posts		
2.	Nails		
3.	Hammer		
4.	Saw		
5.	Wedges		
6.	Tape measure/yardstick, etc.		
7.			
8.			
9.			
10.			

details





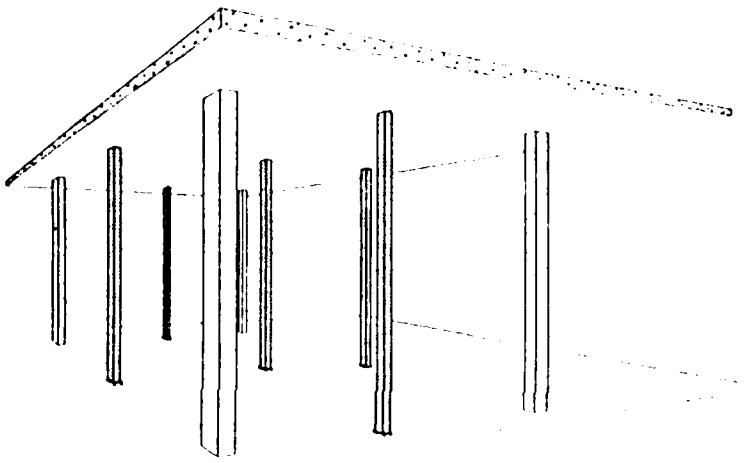
CONCRETE CONSTRUCTION–Floors

FLAT SLAB

post upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber Posts		
2. Nails		
3. Hammer		
4. Saw		
5. Wedges		
6. Tape measure/yardstick, etc.		
7.		
8.		
9.		
10.		



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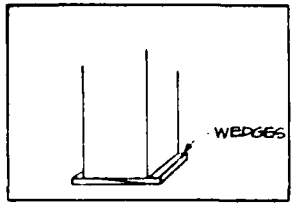


CONCRETE CONSTRUCTION–Floors

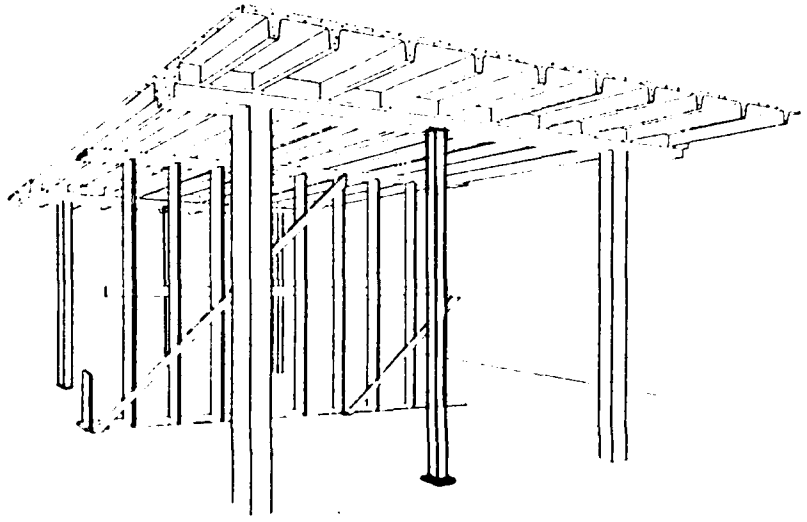
FLAT PLATE

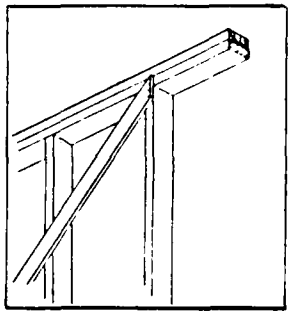
post upgrading

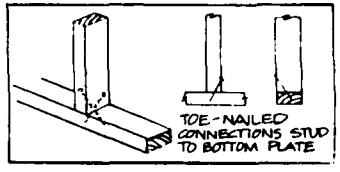
RESOURCE LIST

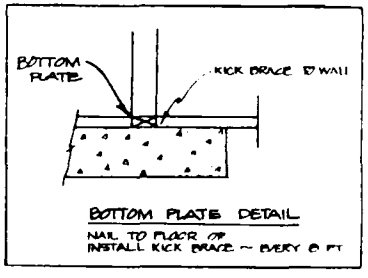
Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		

details



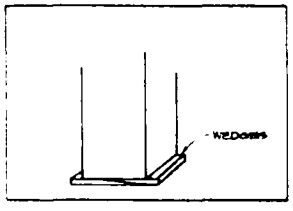






NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x 10	6d, 8d
2 x 10	8d, 10d, 12d
3 x 10	10d, 20d, 30d
4 x 10	40d, 50d, 60d

* where b = width of boards
when b = 2 in. use 2 nails
when b = 4 in. use 3 nails
when b = 6 in. use 4 nails



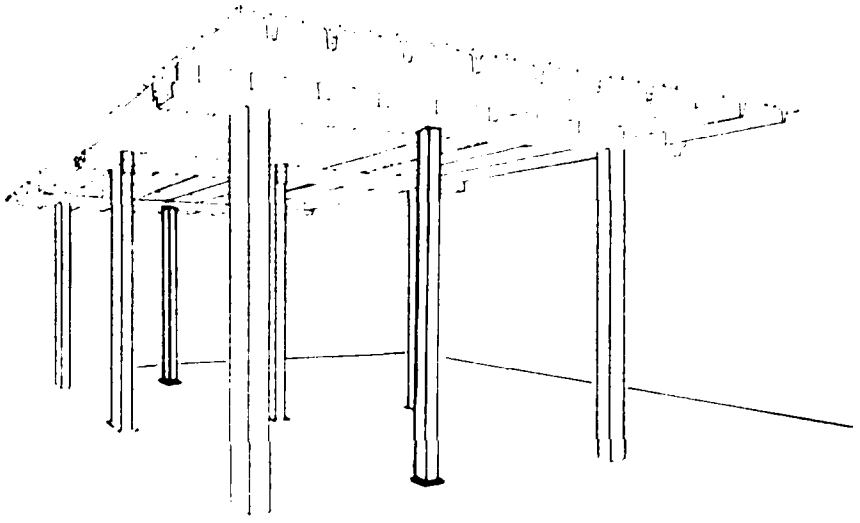
CONCRETE CONSTRUCTION–Floors

ONE–WAY JOIST

stud wall upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Posts)		
2. Timber (Beams)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		



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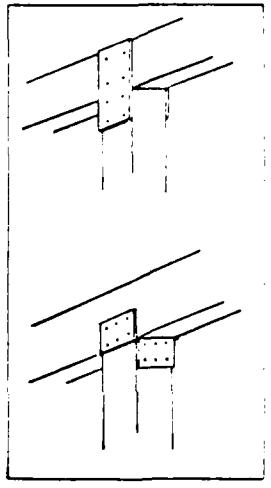
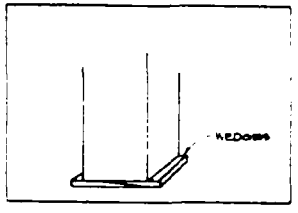


NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x 10	6d, 8d
2 x 10	8d, 10d, 12d
3 x 10	16d, 20d, 30d
4 x 10	40d, 50d, 60d

* where b = width of joists
when b = 2 in. use 2 nails
when b = 4 in. use 3 nails
when b = 6 in. use 4 nails



CONCRETE CONSTRUCTION–Floors

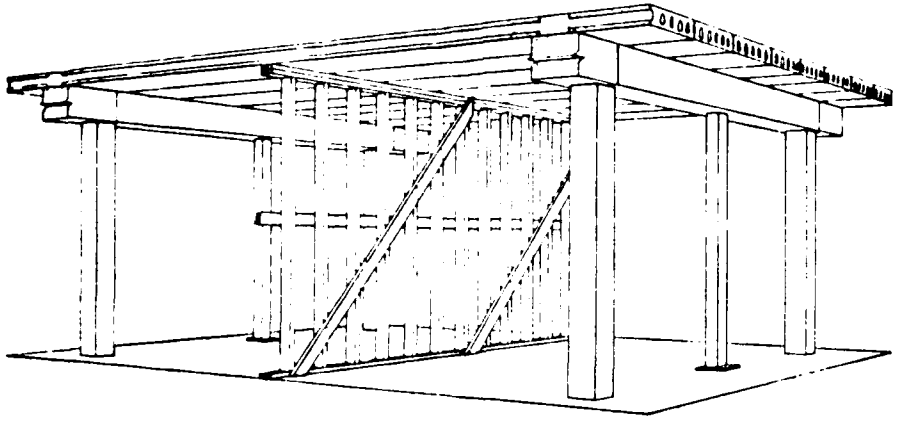
ONE–WAY JOIST

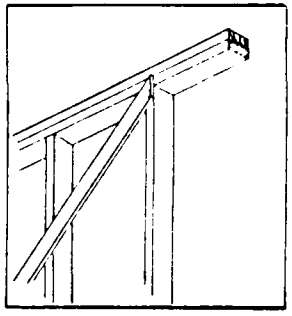
post & beam upgrading

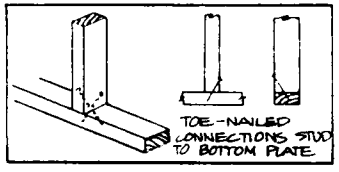
RESOURCE LIST

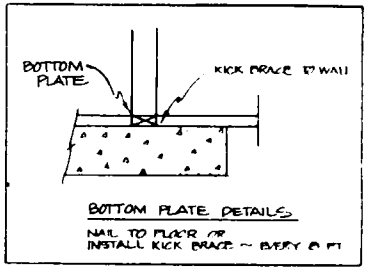
Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		

details



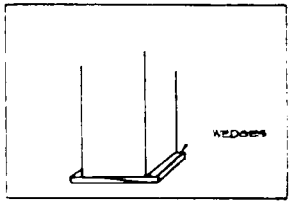






NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
2 x 10	6d, 8d
4 x 10	8d, 10d, 12d
8 x 10	16d, 20d, 30d
12 x 10	40d, 50d, 60d

* where [illegible] width of boards
[illegible] 2 in. use 2 nails
[illegible] 4 in. use 3 nails
[illegible] 6 in. use 4 nails



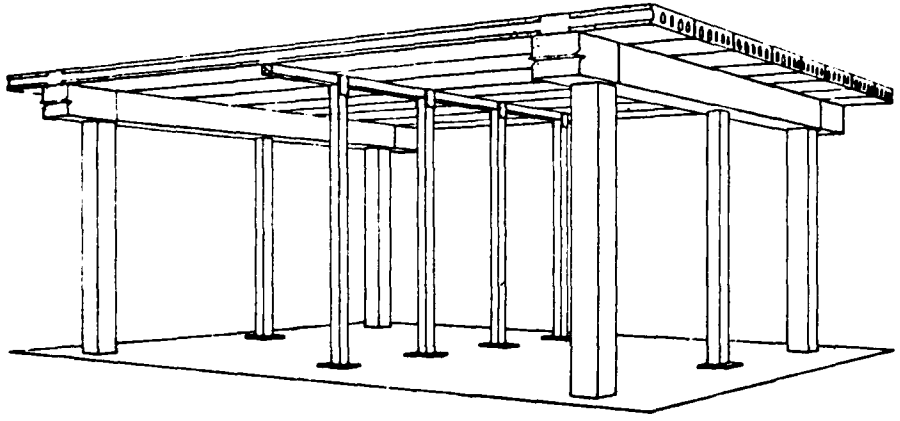
CONCRETE CONSTRUCTION–Floors

HOLLOW-CORE

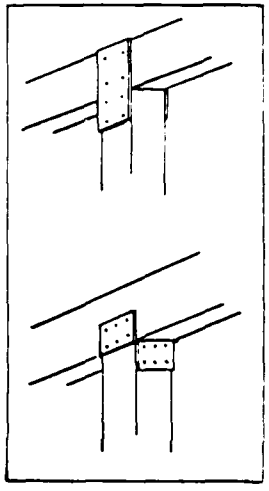
stud wall upgrading

RESOURCE LIST

	Required	Quantity	Available
1.	Timber (Posts)		
2.	Timber (Beams)		
3.	Nails		
4.	Hammer		
5.	Saw		
6.	Wedges		
7.	Tape measure/yardstick, etc.		
8.			
9.			
10.			

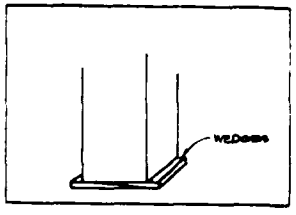


details



NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x b	6d, 8d
2 x b	8d, 10d, 12d
3 x b	16d, 20d, 30d
4 x b	40d, 50d, 60d

* where b = width of boards
when b = 2 in, use 2 nails
when b = 4 in, use 3 nails
when b = 6 in, use 4 nails



CONCRETE CONSTRUCTION–Floors

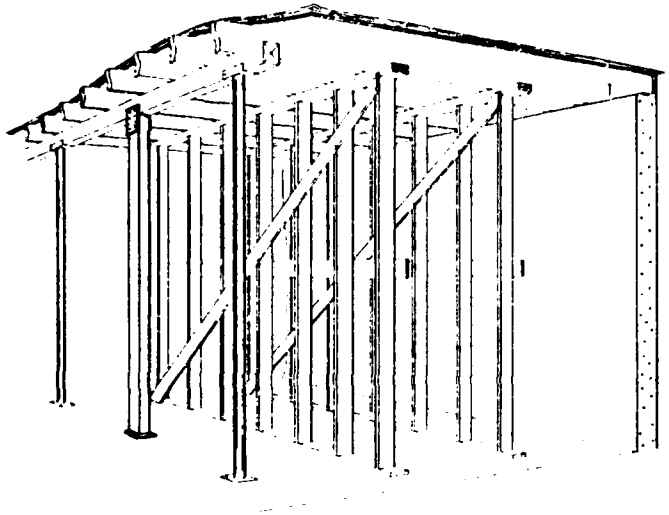
HOLLOW-CORE

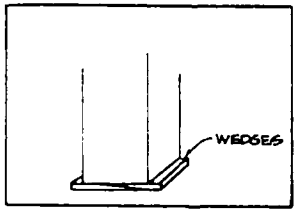
post & beam upgrading

ROOFS

RESOURCE LIST

Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		





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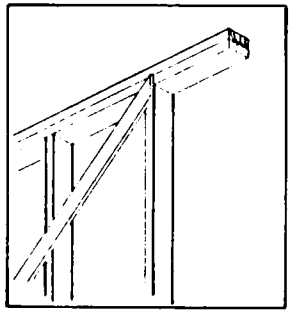
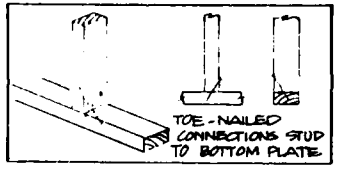
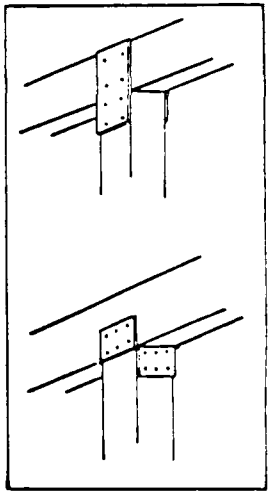
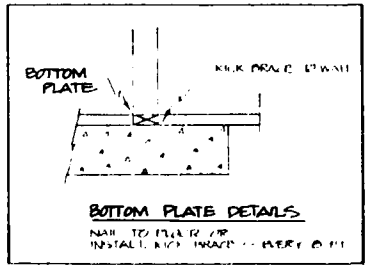


NAILING SCHEDULE	
BOARD SIZE (THICKNESS)	NAIL SIZE
1 x b	6d, 8d
2 x b	8d, 10d, 12d
3 x b	10d, 12d, 16d
4 x b	12d, 16d, 20d

* where b = width of boards
when b = 4" use 2 nails
when b = 6" use 3 nails
when b = 8" use 4 nails







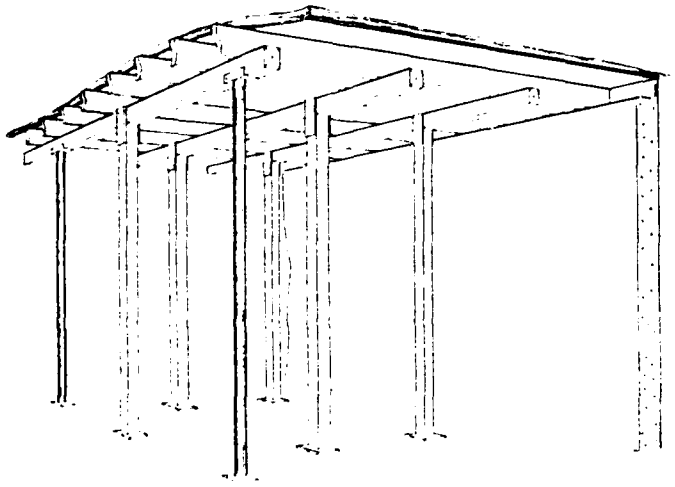
WOOD CONSTRUCTION–Roofs

TIMBER JOIST

stud wall upgrading

RESOURCE LIST

	Required	Quantity	Available
1.	Timber (Posts)		
2.	Timber (Beams)		
3.	Nails		
4.	Hammer		
5.	Saw		
6.	Wedges		
7.	Tape measure/yardstick, etc.		
8.			
9.			
10.			



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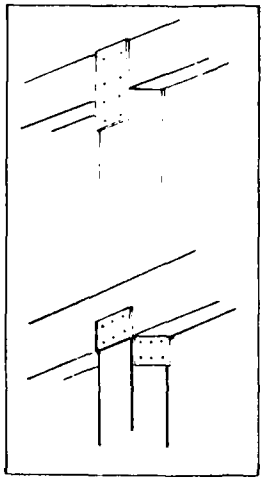
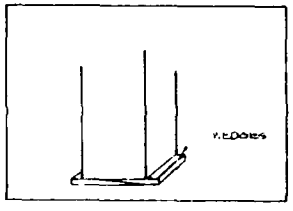
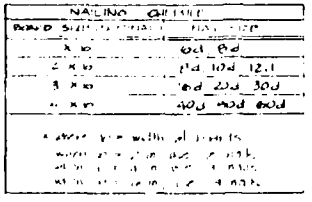






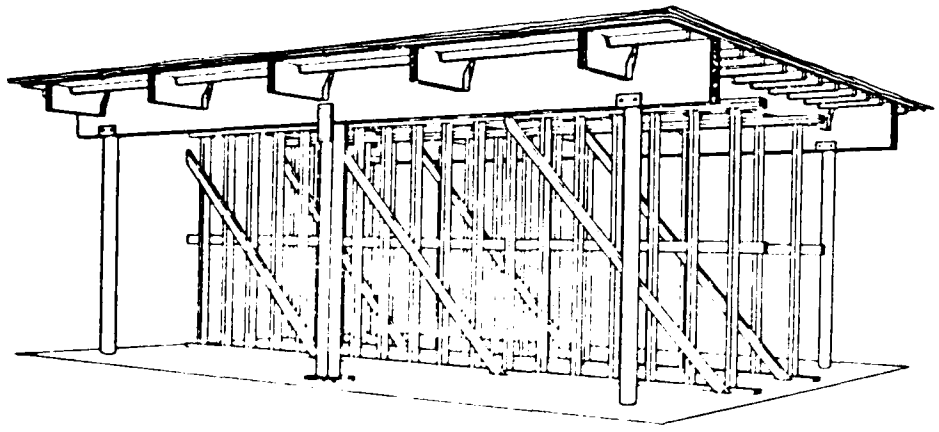
WOOD CONSTRUCTION–Roofs

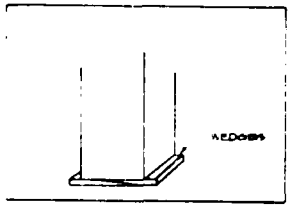
TIMBER JOIST

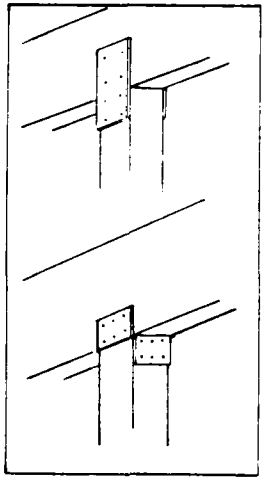
post & beam upgrading

RESOURCE LIST

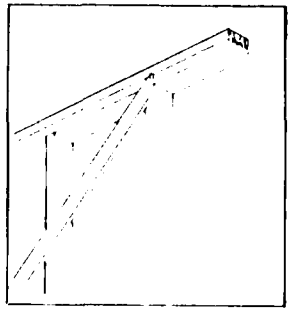
Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		

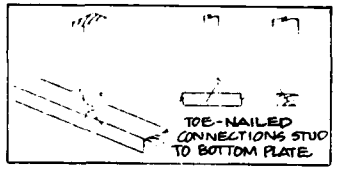


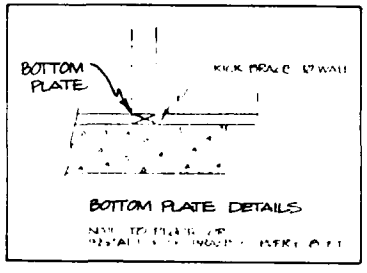




details







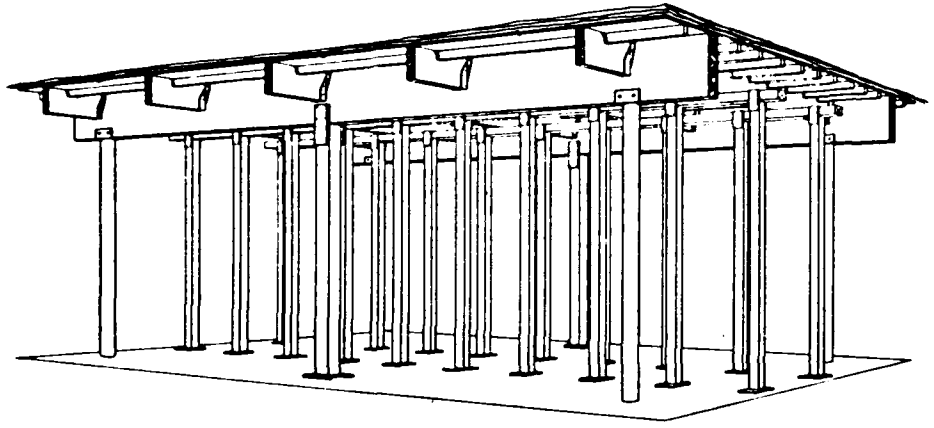
WOOD CONSTRUCTION–Roofs

GLULAM

stud wall upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Posts)		
2. Timber (Beams)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		



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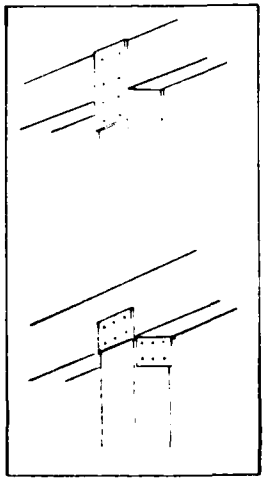
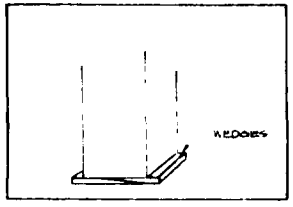




NAILING SCHEDULE	
BEAM SIZE (NOMINAL)	NAIL SIZE
3 x 10	6d 8d
2 x 10	8d 10d 12d
3 x 10	16d 20d 30d
4 x 10	40d 50d 60d

x where b = width of beam
when b = 2 in. use 1 nail
when b = 3 in. use 2 nails
when b = 4 in. use 3 nails

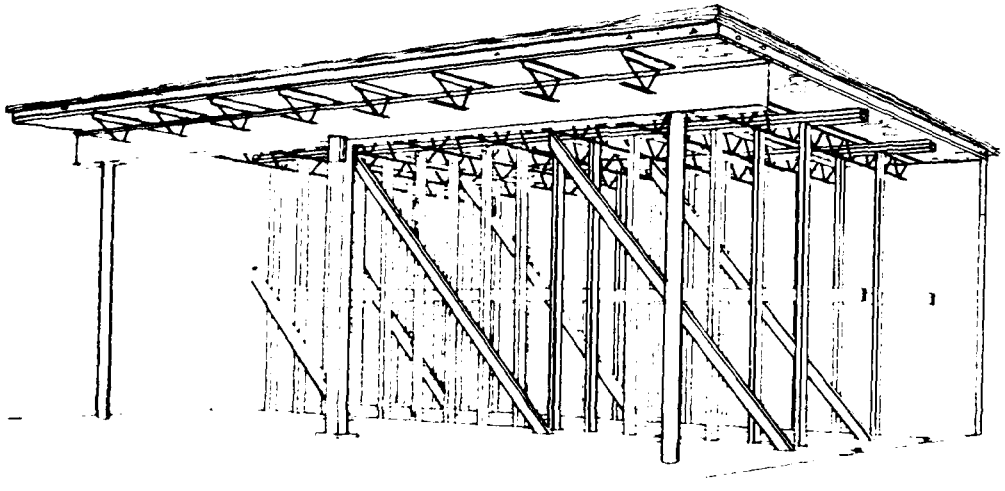
WOOD CONSTRUCTION–Roofs

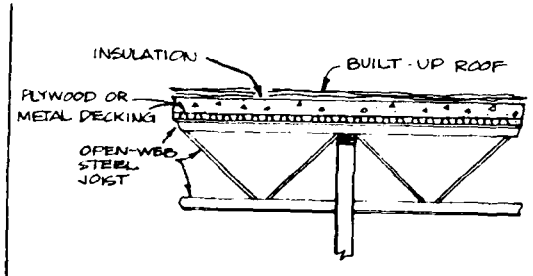
GLULAM

post & beam upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		





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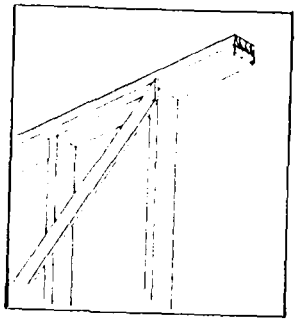
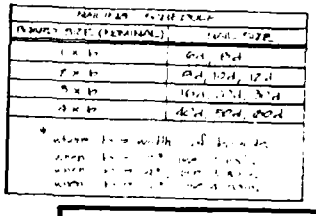
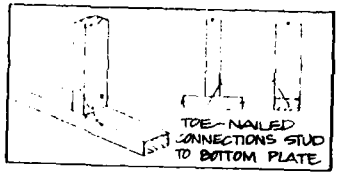
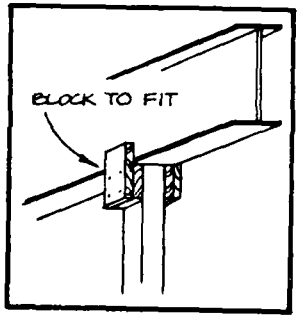
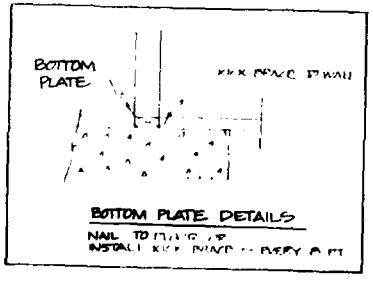
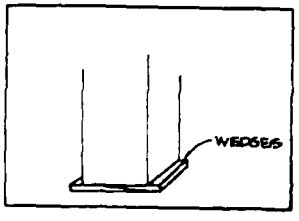












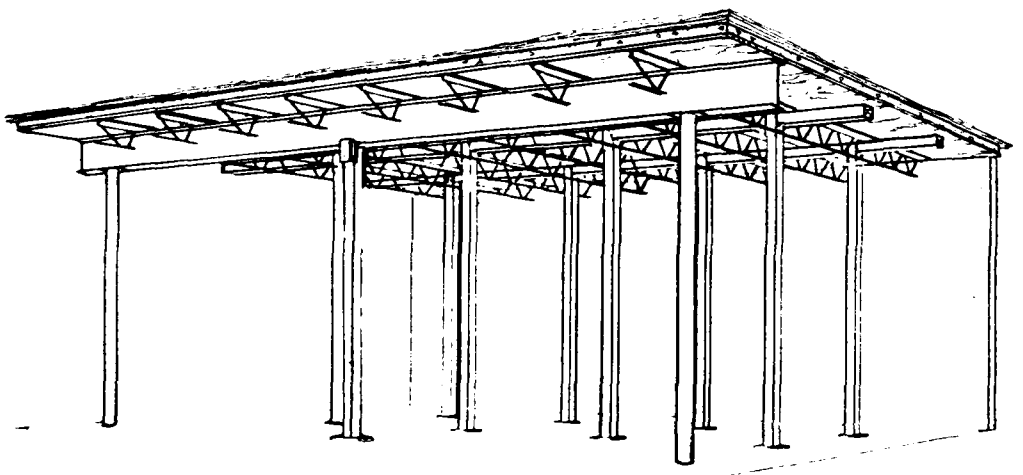
STEEL LIGHT CONSTRUCTION–Roofs

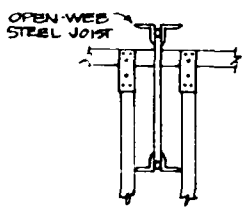
OPEN–WEB JOIST

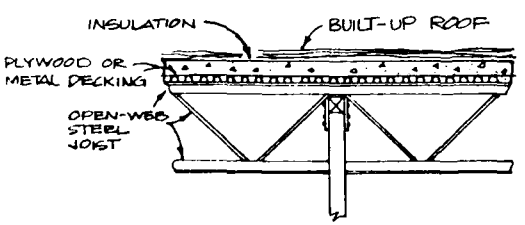
stud wall upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Posts)		
2. Timber (Beams)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		







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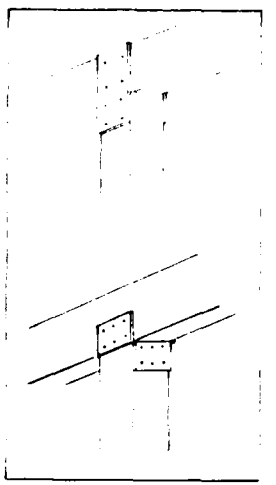

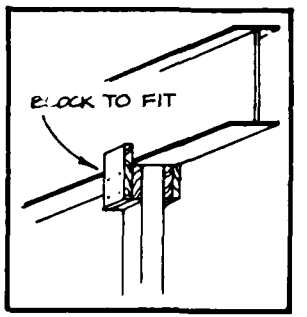

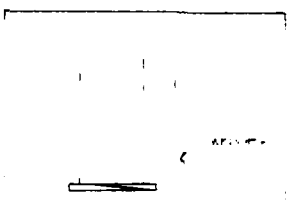

NAILING SCHEDULE	
[illegible]	NAIL SIZE
1 x [illegible]	[illegible]
2 x [illegible]	[illegible]
3 x [illegible]	[illegible]
4 x [illegible]	[illegible]

* where b = width of [illegible]
when b = 2 in. use 2 nails
when b = 3 in. use 3 nails
when b = 4 in. use 4 nails

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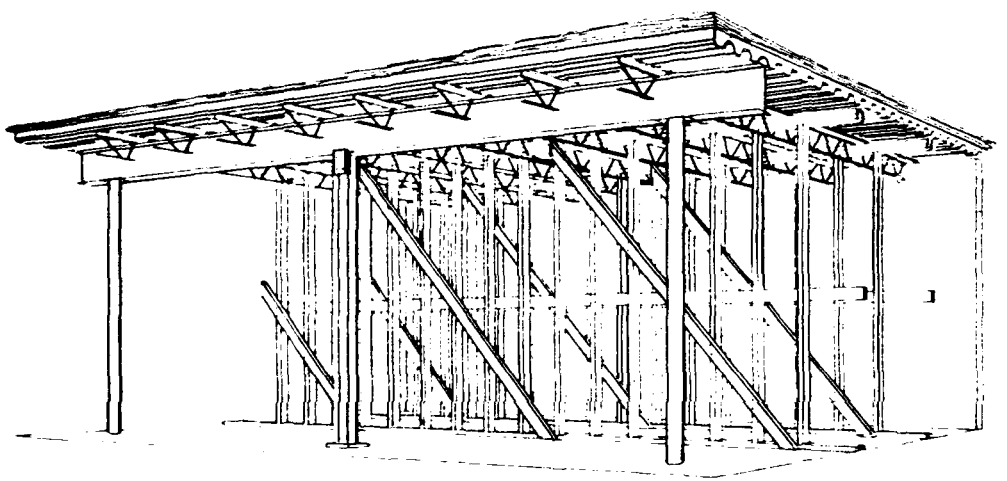
STEEL LIGHT CONSTRUCTION–Roofs

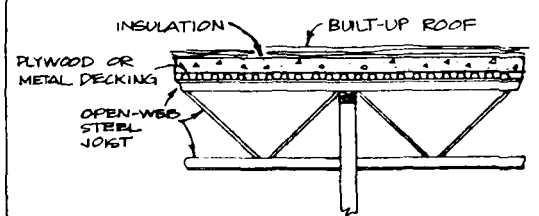
OPEN–WEB JOIST

post & beam
upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		





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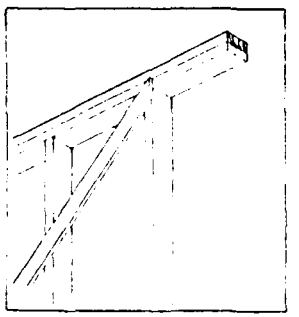
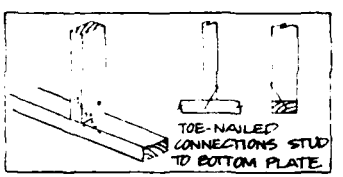
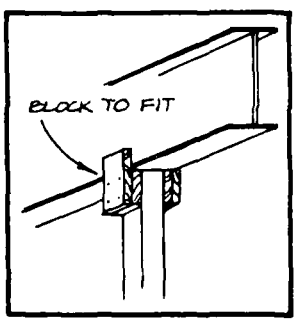


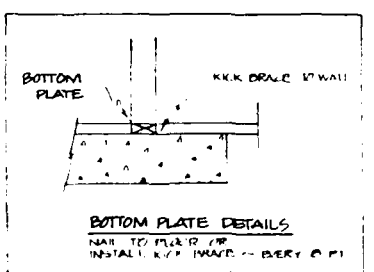
NAILING SCHEDULE

(NOMINAL)	NAIL SIZE
1 x 6	6d, 8d
2 x 6	8d, 10d, 12d
3 x 6	10d, 20d, 30d
4 x 6	40d, 50d, 60d

* width of boards
when 6" use 2 nails
when 8" use 3 nails
when 10" use 4 nails







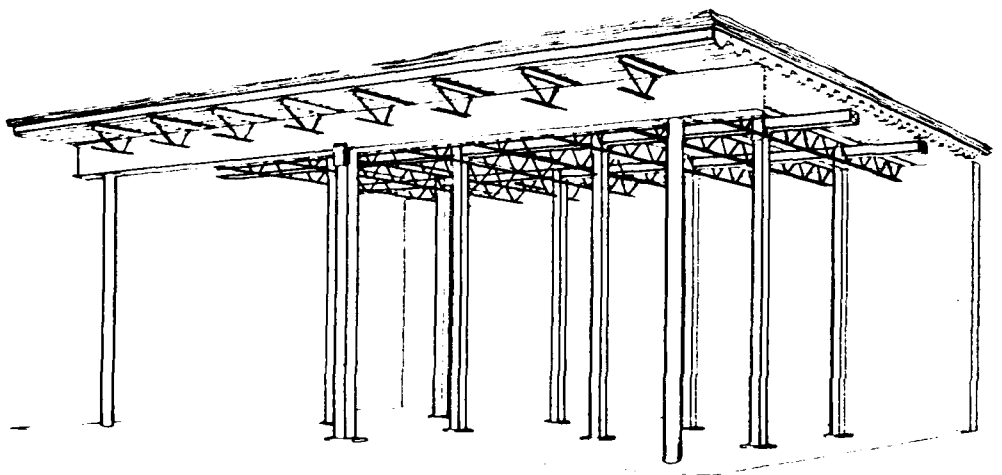
STEEL HEAVY CONSTRUCTION–Roofs

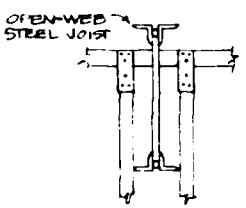
OPEN–WEB JOIST

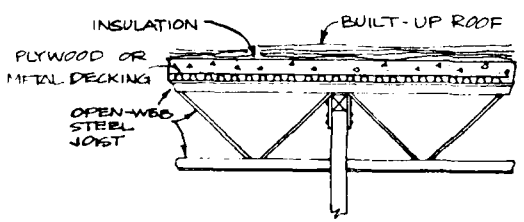
stud wall upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Posts)		
2. Timber (Beams)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		







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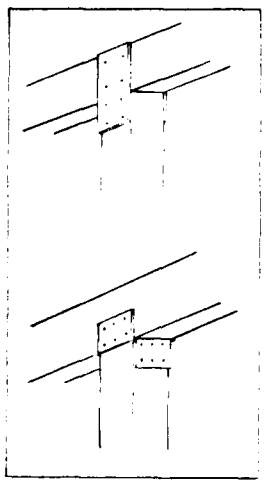
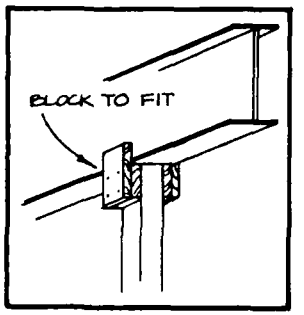
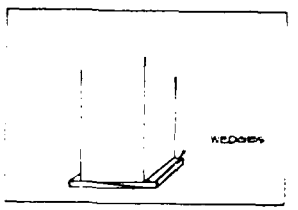






NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x 10	6d 8d
2 x 10	8d 10d 12d
3 x 10	16d 20d 30d
4 x 10	40d 50d 60d

* where [illegible] width of [illegible]
when [illegible] 2 in. use [illegible] nails
when [illegible] 4 in. use [illegible] nails
when [illegible] 6 in. use [illegible] nails

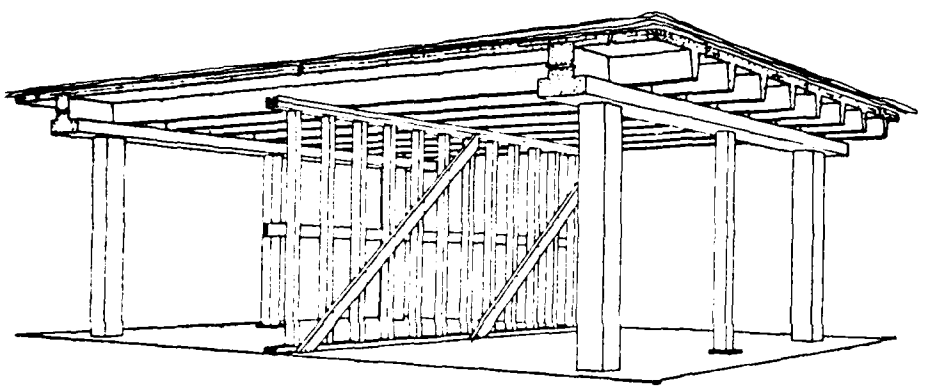
STEEL HEAVY CONSTRUCTION–Roofs

OPEN–WEB JOIST

post & beam upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		



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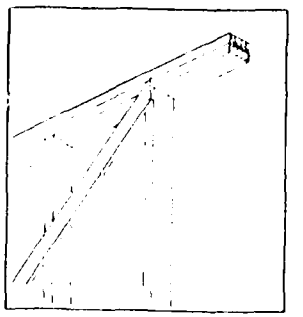
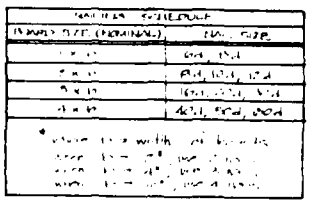
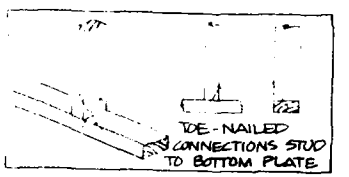
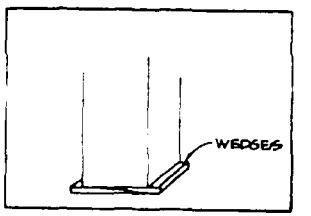
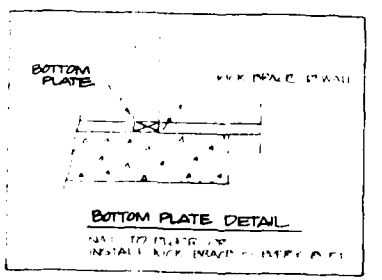










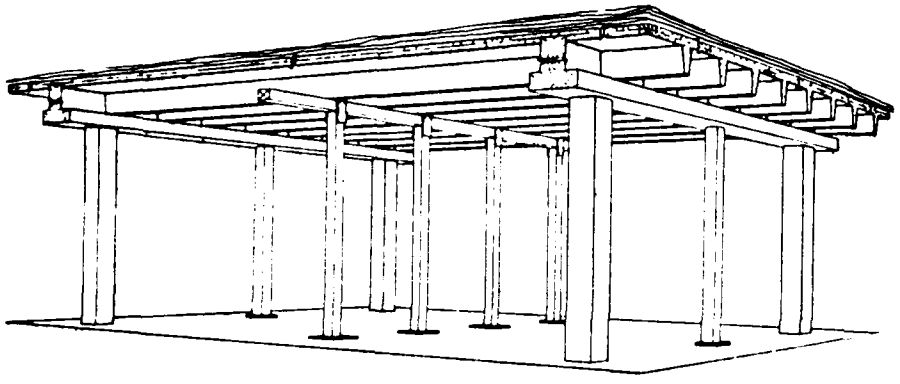
CONCRETE CONSTRUCTION–Roofs

DOUBLE TEE

stud wall upgrading

RESOURCE LIST

	Required	Quantity	Available
1.	Timber (Posts)		
2.	Timber (Beams)		
3.	Nails		
4.	Hammer		
5.	Saw		
6.	Wedges		
7.	Tape measure/yardstick, etc.		
8.			
9.			
10.			



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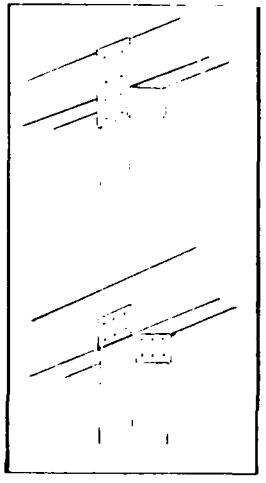

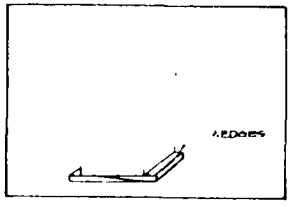

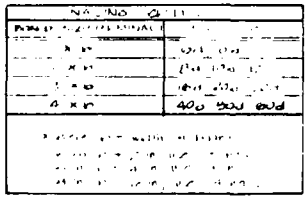

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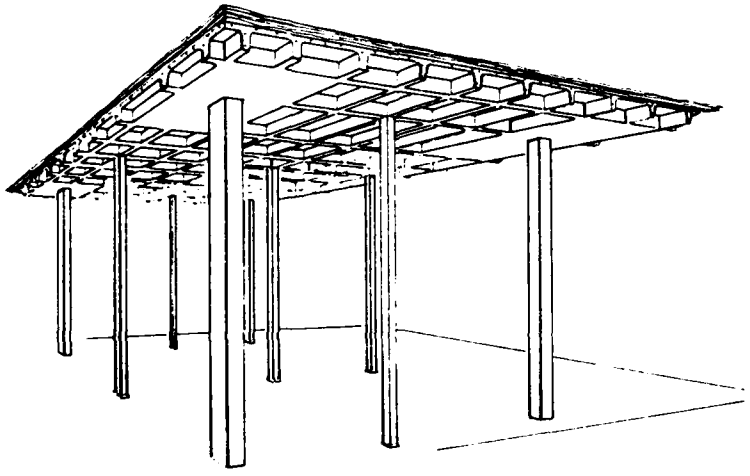
CONCRETE CONSTRUCTION–Roofs

DOUBLE TEE

post & beam
upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber Posts		
2. Nails		
3. Hammer		
4. Saw		
5. Wedges		
6. Tape measure/yardstick, etc.		
7.		
8.		
9.		
10.		



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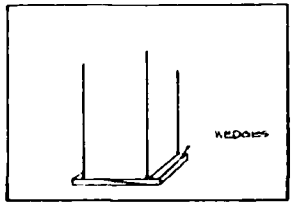


CONCRETE CONSTRUCTION–Roofs

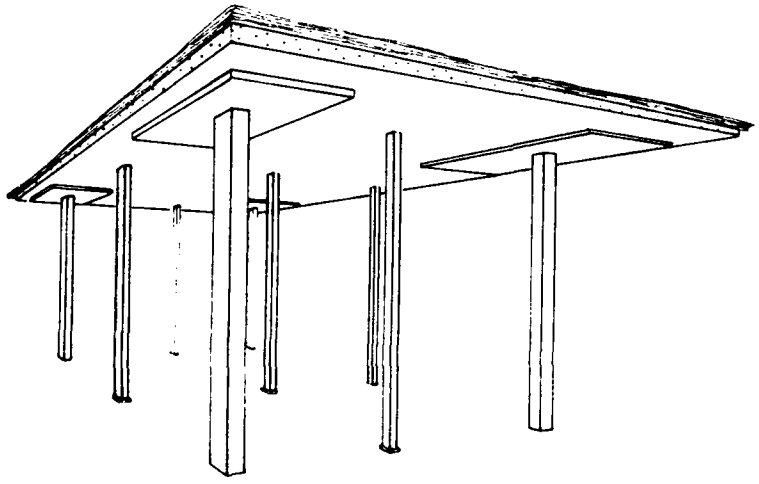
WAFFLE SLAB

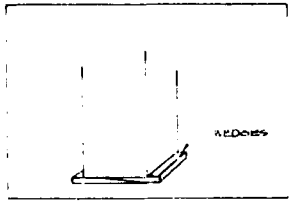
post upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber Posts		
2. Nails		
3. Hammer		
4. Saw		
5. Wedges		
6. Tape measure/yardstick, etc.		
7.		
8.		
9.		
10.		

details





CONCRETE CONSTRUCTION–Roofs

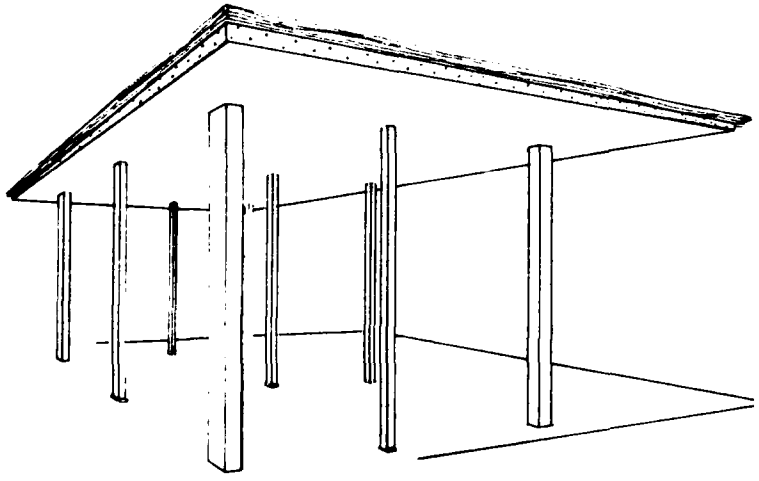
FLAT SLAB

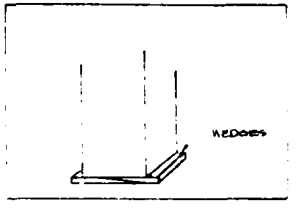
post upgrading

RESOURCE LIST

	Required	Quantity	Available
1.	Timber Posts		
2.	Nails		
3.	Hammer		
4.	Saw		
5.	Wedges		
6.	Tape measure/yardstick, etc.		
7.			
8.			
9.			
10.			

details





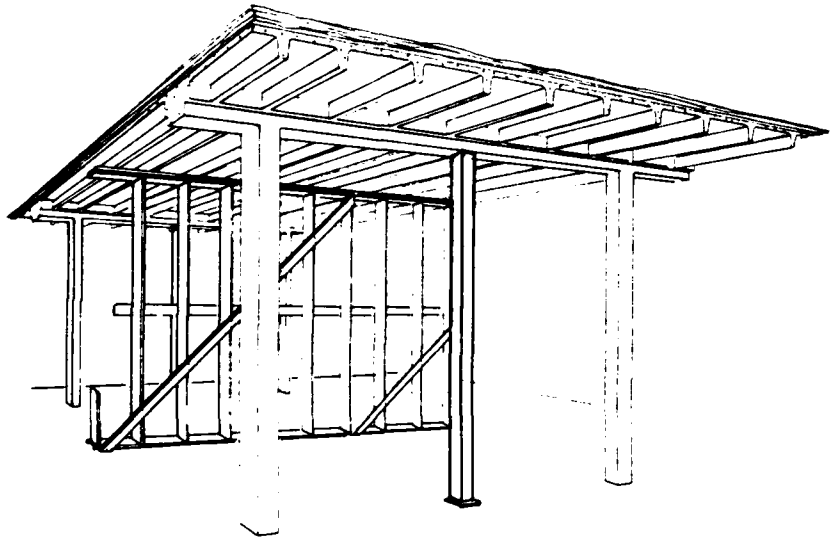
CONCRETE CONSTRUCTION–Roofs

FLAT PLATE

post upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		



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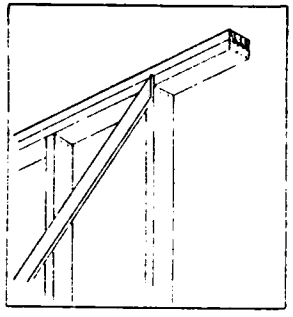
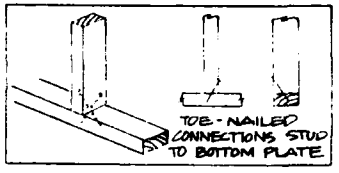
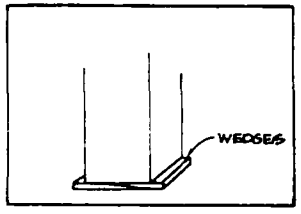
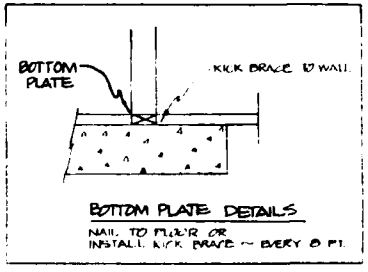


NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE
1 x b	6d, 8d
2 x b	8d, 10d, 12d
3 x b	16d, 20d, 30d
4 x b	40d, 50d, 60d

* where b = width of boards
when b = 2", use 2 nails
when b = 4", use 3 nails
when b = 6", use 4 nails







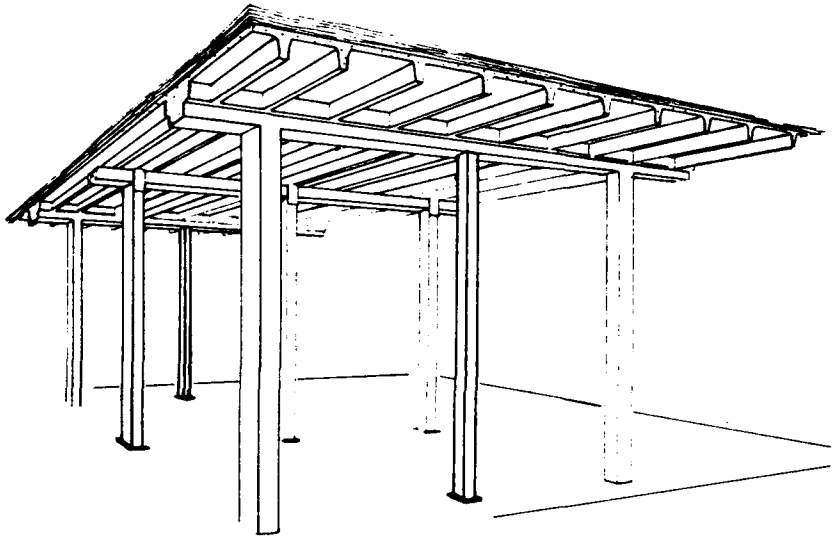
CONCRETE CONSTRUCTION–Roofs

ONE–WAY JOIST

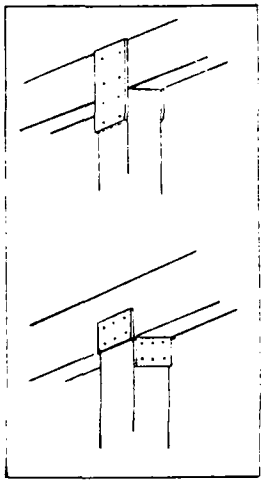
stud wall upgrading

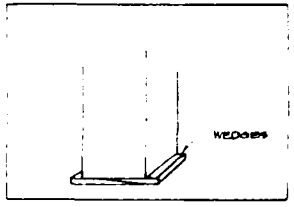
RESOURCE LIST

	Required	Quantity	Available
1.	Timber (Posts)		
2.	Timber (Beams)		
3.	Nails		
4.	Hammer		
5.	Saw		
6.	Wedges		
7.	Tape measure/yardstick, etc.		
8.			
9.			
10.			



details





NAILING GUIDE	
BEAM SIZE (NOMINAL)	NAIL SIZE
2 x 6	6d, 8d
2 x 8	8d, 10d, 12d
3 x 8	16d, 20d, 30d
4 x 8	40d, 50d, 60d

* where n = width of boards
when n = 2 in. use 2 rows
when n = 4 in. use 3 rows
when n = 6 in. use 4 rows

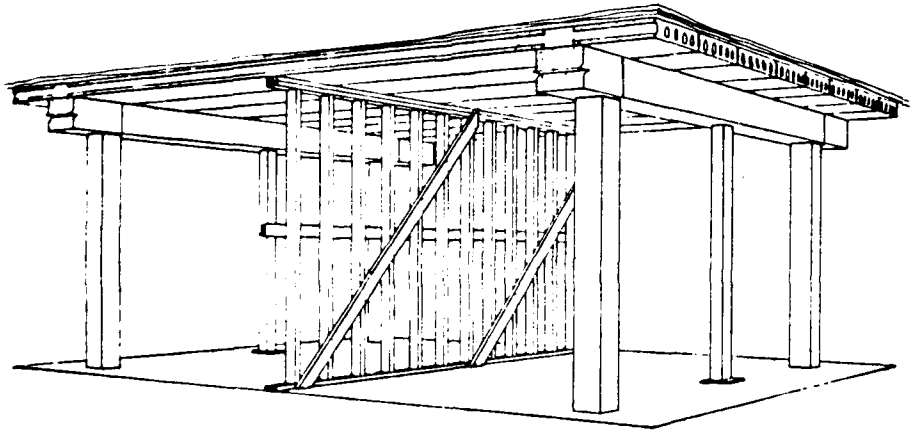
CONCRETE CONSTRUCTION–Roofs

ONE–WAY JOIST

post & beam upgrading

RESOURCE LIST

Required	Quantity	Available
1. Timber (Studs & Plates)		
2. Bracing Material (Plywood Sheeting or nom. 1-in. Timber)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		



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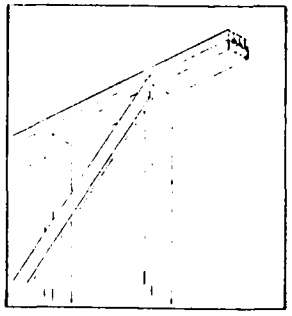
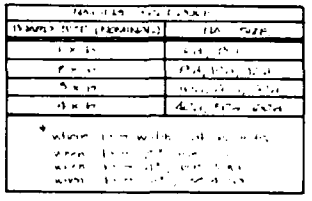
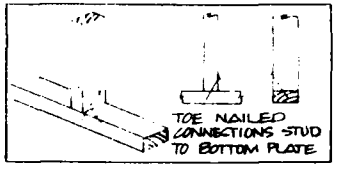
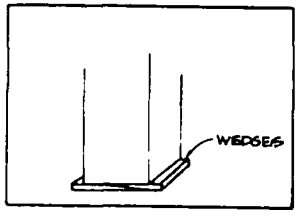
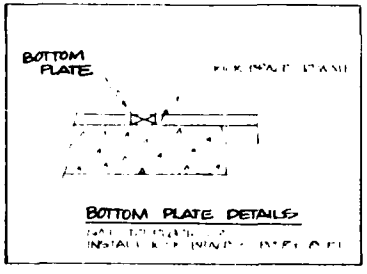








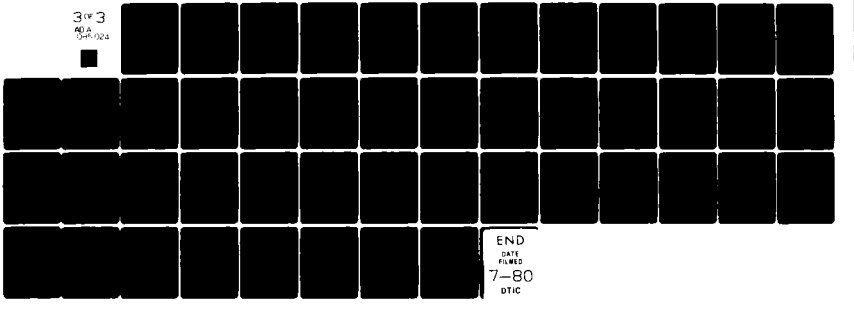


CONCRETE CONSTRUCTION–Roofs

HOLLOW-CORE

stud wall upgrading

AD-A085 024 SCIENTIFIC SERVICE INC REDWOOD CITY CA F/G 13/13
SHELTER UPGRADING MANUAL: HOST AREA SHELTERS.(U)
MAR 80 C WILTON, B L GABRIELSEN, R S TANSLEY DCPA01-78-C-0215
UNCLASSIFIED SSI-7815-8 NL



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DATE FILMED
7-80
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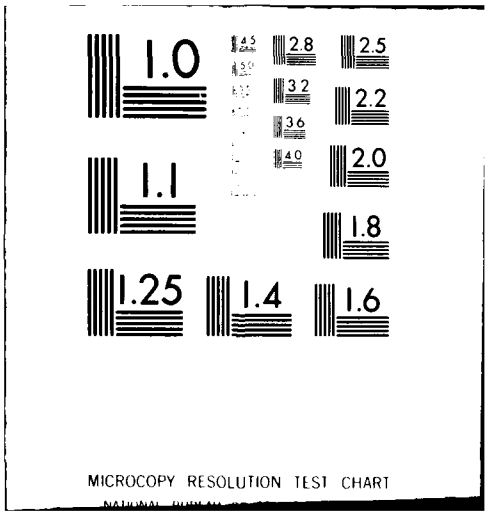
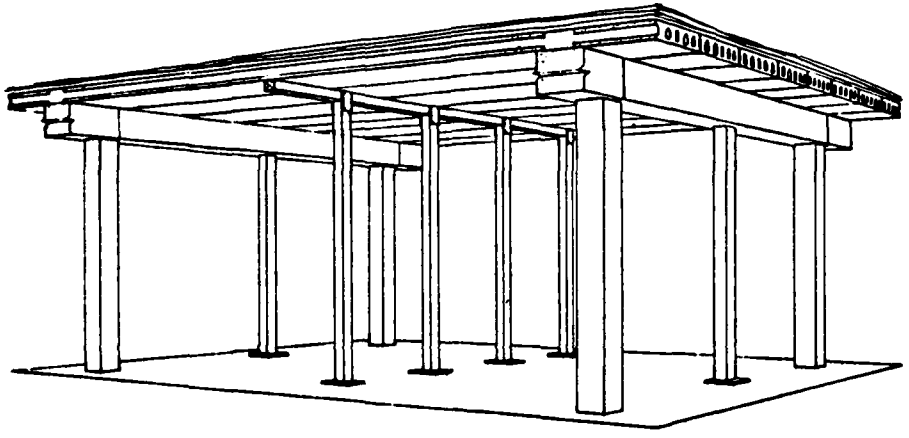

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART

RESOURCE LIST

Required	Quantity	Available
1. Timber (Posts)		
2. Timber (Beams)		
3. Nails		
4. Hammer		
5. Saw		
6. Wedges		
7. Tape measure/yardstick, etc.		
8.		
9.		
10.		



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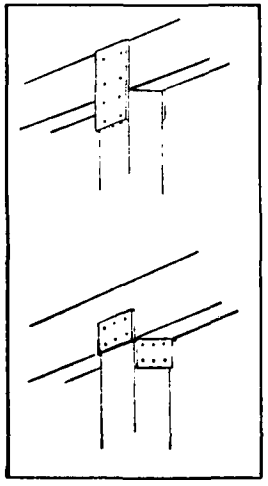
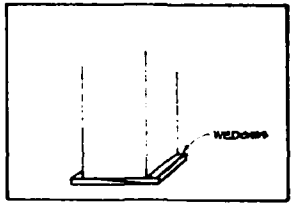




NAILING SCHEDULE	
BOARD SIZE (NOMINAL)	NAIL SIZE*
1 x 6	6d, 8d
2 x 6	8d, 10d, 12d
3 x 6	16d, 20d, 30d
4 x 6	40d, 50d, 60d

* where b = width of boards
when b = 2 in, use 2 nails
when b = 4 in, use 3 nails
when b = 6 in, use 4 nails

CONCRETE CONSTRUCTION–Roofs

HOLLOW–CORE

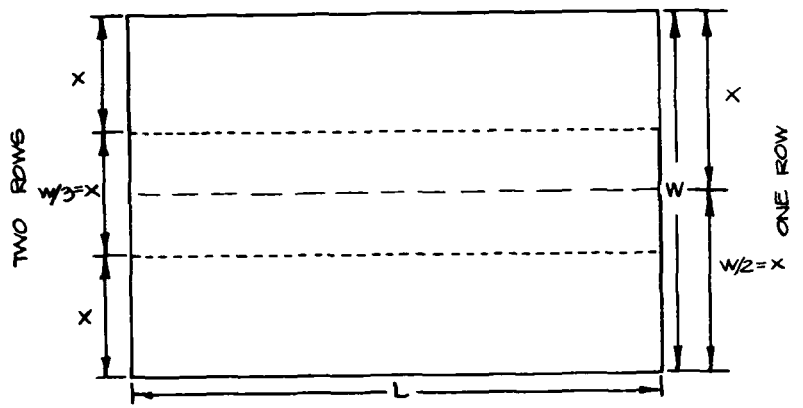
post & beam upgrading

SECTION 7

WORKSHEETS

INDEX

WORKSHEET A stud wall upgrading



L _____ *W* _____ *H* _____

1. Measure the intended shelter area. Fill in the length (L), width (W), and height (H) of the area in the spaces provided above. These dimensions need not be exact - the length and width to the nearest foot and the height to the nearest 6 in. is sufficient.

2. Sketch in the figure above the intended location of the stud wall(s). If one wall is used, it should be located at midspan along dashed line (W/2) and if two are used, at 1/3 span (W/3) along dotted lines. The wall (s) should be continuous the full length (L) of the area.

3. Determine the distance (X) from the stud wall to the adjacent support (wall, beam, other stud wall, etc.).

   X = _____ ft

4. With (X) and (H) from above, go to Chart A, page 8-1, Section 8, to determine the timber size required; enter Chart A from left with (X) and read over to ceiling height (H). Read above intersection point to find the size of studs and spacing that may be used.

   Stud Size _____ in. by _____ in.

   at _____ in. on center.

5. Timber Requirements: With the above information, a rough estimate may be made of the timber required for the upgrading.

   Studs _____ in. by _____ in.

   $$\frac{H \text{ ____ ft} \times L \text{ ____ ft} \times 12}{\text{____ in. on center}} = \text{____ lin. ft}$$

   Top Plates (same size as studs, two required)

   L _____ ft x 2 = _____ lin. ft

   Bottom Plate (same size as studs, one required)

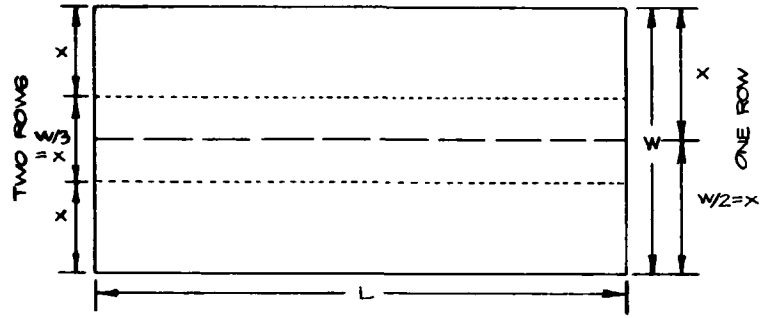
   L _____ ft x 1 = _____ lin. ft

   Total Timber Required = _____ lin. ft

   Note: If two walls are used, double the above timber requirement. Enter size and linear feet of timber required on the Resources List.

6. If existing ceiling support(s) are beams in lieu of bearing walls, additional shoring should be provided. Use Worksheet G, page 7-7, Section 7 - Beam Shoring, to determine post shores required.

WORKSHEET B post & beam upgrading



L _____ W _____ H _____

1. Measure the intended shelter area. Fill in the length (L), width (W), and height (H) of the area in the spaces provided above. These dimensions need not be exact – the length and width to the nearest foot and the height to the nearest 6 in. is sufficient.

2. Sketch in the figure above the intended location of the timber beams and locate the timber posts required to support them. If one line of beams is used, it should be located at midspan (W/2) along dashed line , and if two are used, at 1/3 span (W/3) along dotted lines. The line(s) of posts and beams should be continuous the full length (L) of the area.

3. Determine the distance (X) from the beam line to the adjacent support (wall, beam, etc.).

   X = _____ ft

   Determine the distance between the posts (Y).

   Y = _____ ft

   Multiply X x Y = _____ sq ft supported area.

4. With the supported area and (H) from above, go to Chart B, page 8-2, Section 8, to determine the timber post size required. Enter the chart from the left with the supported area and read over to ceiling height. Read above the intersection point to find the size of timber posts that may be used.

   Post Size _____ in. by _____ in.

5. To determine the required beam size, go to Chart C, page 8-3, Section 8. Enter chart from left with the distance between supports (X) and read over to the distance between posts, or span (Y). Read above intersection point to find the size of timber beams that may be used.

   Beam Size _____ in. by _____ in.

6. Timber Requirements: With the above information, a rough estimate may be made of the timber required for the upgrading.

   Posts _____ in. by _____ in.

   No. of Posts ___ x H _____ ft = _____ lin. ft

   Beams _____ in. by _____ in.

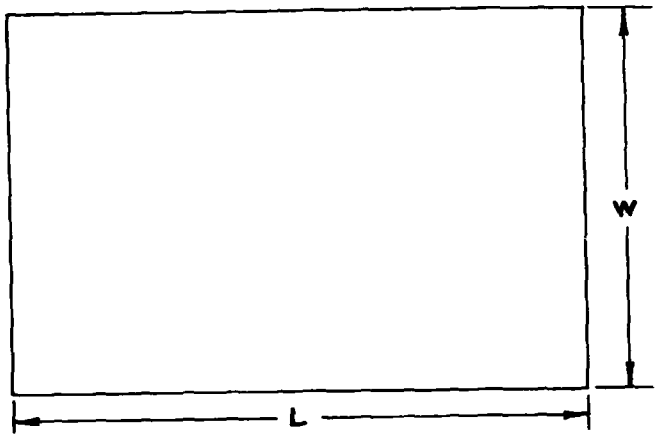
   L = _____ lin. ft

   Total Timber Required = _____ lin. ft

   Note: If two lines of shoring are used, double the above timber requirement. Enter size and linear feet of timber required on Resources List.

7. If existing ceiling support(s) are beams in lieu of bearing walls, additional shoring should be provided. Use Worksheet G, page 7-7, Section 7 - Beam Shoring, to determine post shores required.

WORKSHEET C king post truss upgrading



L _____ W _____ H _____

1. Measure the intended shelter area. Fill in the length (L), width (W), and height (H) of the area in the spaces provided above. These dimensions need not be exact — the length and width to the nearest foot and the height to the nearest 6 in. is sufficient.

2. The material requirements for King Post Truss upgrading vary greatly with the type of system to be upgraded. The details, shown with each of the individual sketches depicting the upgrading scheme, should be examined closely. Various methods of attachment and installation are suggested for each scheme. Once a scheme has been selected, identification and a count of all the anchors and attachments required should be made, and this information entered on the Resources List.

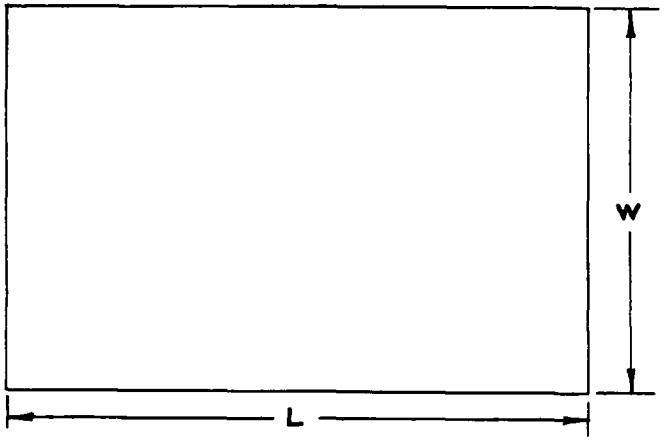
3. To determine the amount of cable required, count the number of joists and/or beams to be upgraded (N) and multiply by their length (W). Two feet should be added to each member length to account for end anchorages and initial cable slack, which is desired for ease in installation. Cable requirements may then be determined as follows:

(W + 2)_____ ft x N _____ = _____ lin. ft

Note: If two cables are required per joist/beam (see sketch of upgrading scheme), double the above requirement. Enter the linear feet of cable required on Resources List.

4. If existing ceiling support(s) are beams in lieu of bearing walls, additional shoring should be provided. Use Worksheet G, page 7-7, Section 7 - Beam Shoring, to determine post shores required.

WORKSHEET D flange upgrading



L _____ W _____ H _____

1. Measure the intended shelter area. Fill in the length (L), width (W), and height (H) of the area in the spaces provided below illustration. These dimensions need not be exact – the length and width to the nearest foot and the height to the nearest 6 in. is sufficient.

2. Determine the number of joists in the intended shelter area (N).

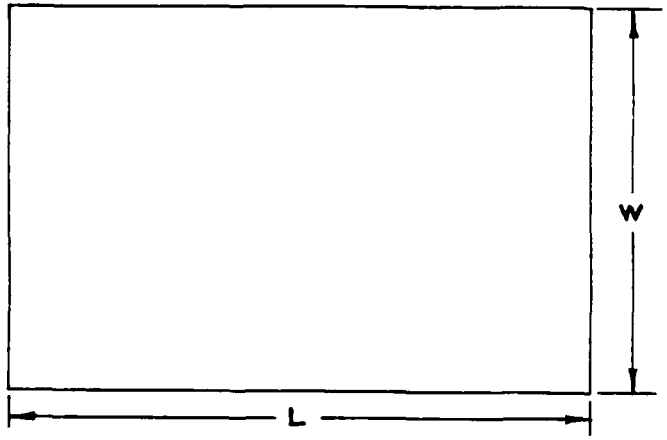
3. Timber Requirements: With the above information, a rough estimate may be made of the timber required for the upgrading.

   N _____ x W _____ ft = _____ lin. ft

   Enter the linear feet of timber required on Resources List.

4. If existing ceiling support(s) are beams in lieu of bearing walls, additional shoring should be provided. Use Worksheet G, page 7-7, Section 7 – Beam Shoring, to determine post shores required.

WORKSHEET E boxed beam upgrading



L_____ W_____ H_____

1. Measure the intended shelter area. Fill in the length (L), width (W), and height (H) of the area in the spaces provided below illustration. These dimensions need not be exact – the length and width to the nearest foot and the height to the nearest 6 in. is sufficient.

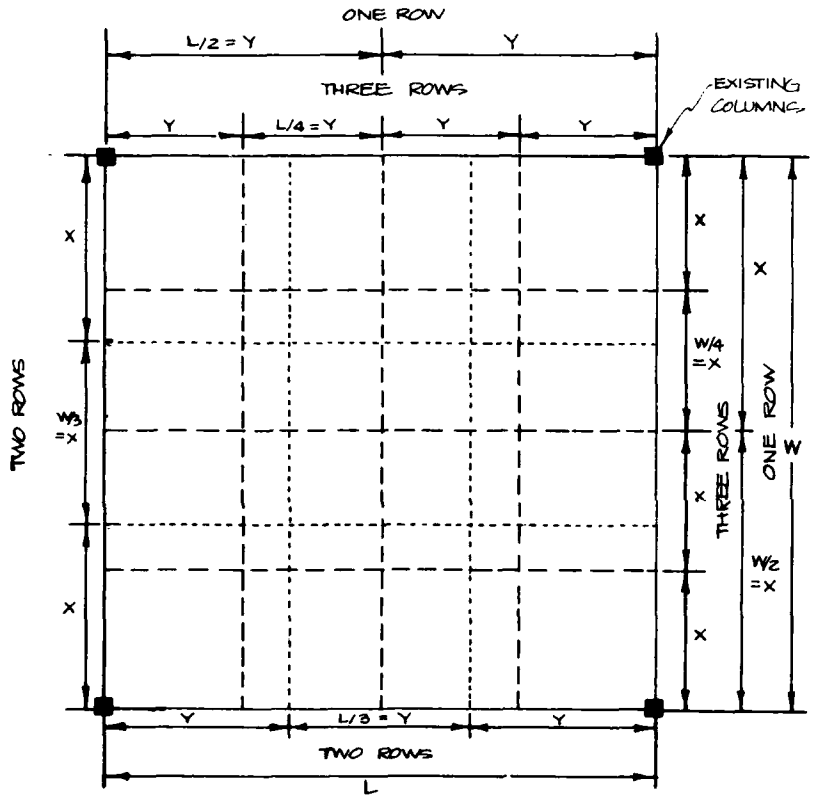
2. Plywood Requirements: With the above information, a rough estimate of the plywood required for the upgrading may be made.

W _____ ft x L _____ ft x 2 = _____ sq ft

Enter the square feet of plywood required on Resources List.

3. If existing ceiling support(s) are beams in lieu of bearing walls, additional shoring should be provided. Use Worksheet G, page 7-7, Section 7 — Beam shoring, to determine post shores required.

WORKSHEET F post upgrading



L _____ *W* _____ *H* _____

1. Measure the intended shelter area. Fill in the length (L), width (W), and height (H) of the area in the spaces provided above. These dimensions need not be exact — the length and width to the nearest foot and the height to the nearest 6 in. is sufficient.

2. Sketch in location of timber posts on illustration symmetrically throughout the shelter area. The posts would be located at the intersections of the dashed or dotted lines as follows: midspan, center dashed lines (W/2 and L/2); 1/3 span, dotted lines (W/3 and L/3); 1/4 span, all dashed lines (W/4 and L/4). The posts should also be located at the intersections of these lines with the line between existing columns.

3. Determine the supported area of each post by multiplying the distance between posts in each direction (X and Y). X would be equal to either W/2, W/3 or W/4, and Y would be equal to L/2, L/3 or L/4, depending on the post locations. Therefore:

   X ____ ft x Y ____ ft = _____ sq ft supported area

4. With the supported area and (H) from above, go to Chart D, page 8-4, Section 8, to determine the timber post size required. Enter the chart from left with the supported area and read over to ceiling height. Read above the intersection point to find the size of timber post that may be used.

   Post Size _____ in. by _____ in.

5. Timber Requirements: With the above information, a rough estimate may be made of the timber required for the upgrading.

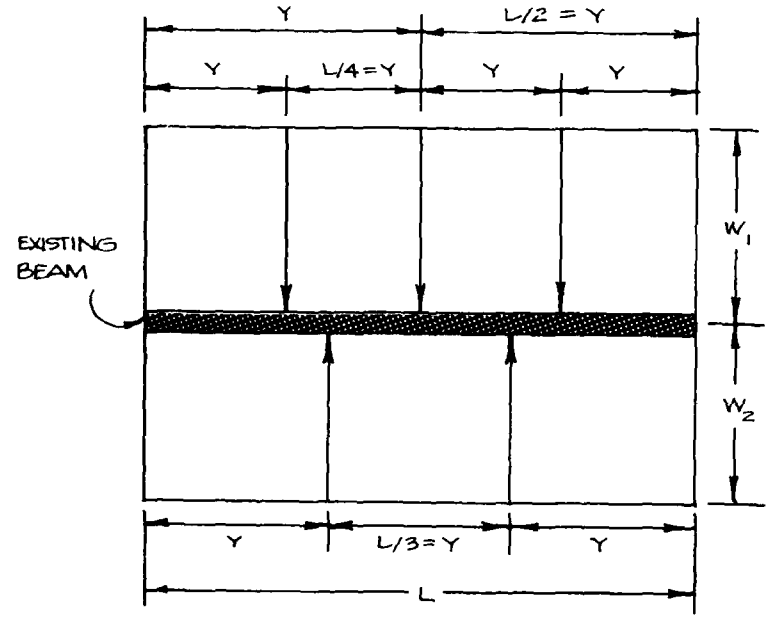
   Posts _____ in. by _____ in.

   No. of Posts ____ x H _____ ft = _____ lin. ft

   Enter size and linear feet of timber required on Resources List.

6. If existing ceiling support(s) are beams in lieu of bearing walls, additional shoring should be provided. Use Worksheet G, page 7-7, Section 7 — Beam Shoring, to determine post shores required.

WORKSHEET G beam shoring



L _____ W1 _____ H _____

W2 _____

1. This Worksheet is to be used when the existing ceiling support(s) are beams in lieu of bearing walls. These beams require upgrading with timber posts.

2. Measure the intended shelter area. Fill in the length (L), widths (W_1 and W_2), and height (H) of the area in the spaces provided above. These dimensions need not be exact – the length and width to the nearest foot and the height to the nearest 6 in. is sufficient.

3. Sketch in the figure above the intended location of the posts along the existing beam. They should be located symmetrically at L/2, L/3, or L/4.

4. Determine the distance between the posts (Y).

Y = _____ ft

Calculate (X).

$$\frac{W_1 + W_2}{2} = X = \_\_\_\_\_ \text{ ft}$$

Multiply X x Y = _____ sq ft supported area

5. With the supported area and (H) from above, go to either Chart B, page 8-2, or Chart D, page 8-4, Section 8, to determine the timber post size required. Use Chart B if the post is supporting a timber beam and Chart D if the post is supporting a beam <u>other</u> than timber (steel, concrete, etc.). Enter the appropriate chart from the left with the supported area and read over to ceiling height. Read above the intersection point to find the size of timber post that may be used.

Post Size _____ in. by _____ in.

6. <u>Timber Requirements</u>: With the above information, a rough estimate may be made of the timber required for the upgrading.

<u>Post</u> _____ in. by _____ in.

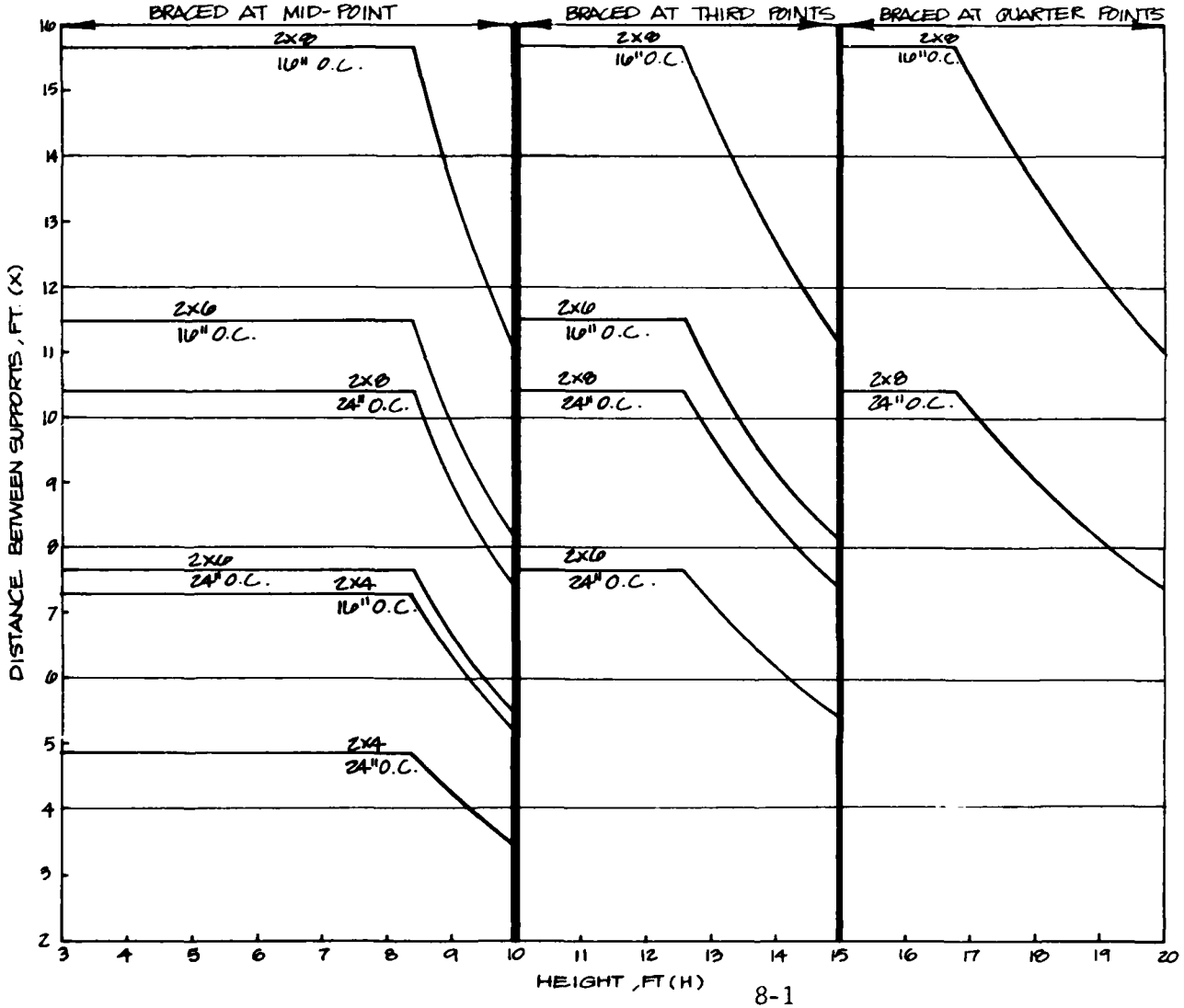
No. of Posts ____ x H ____ ft = _____ lin. ft

Enter size and linear feet of timber required on Resources List.

SECTION 8

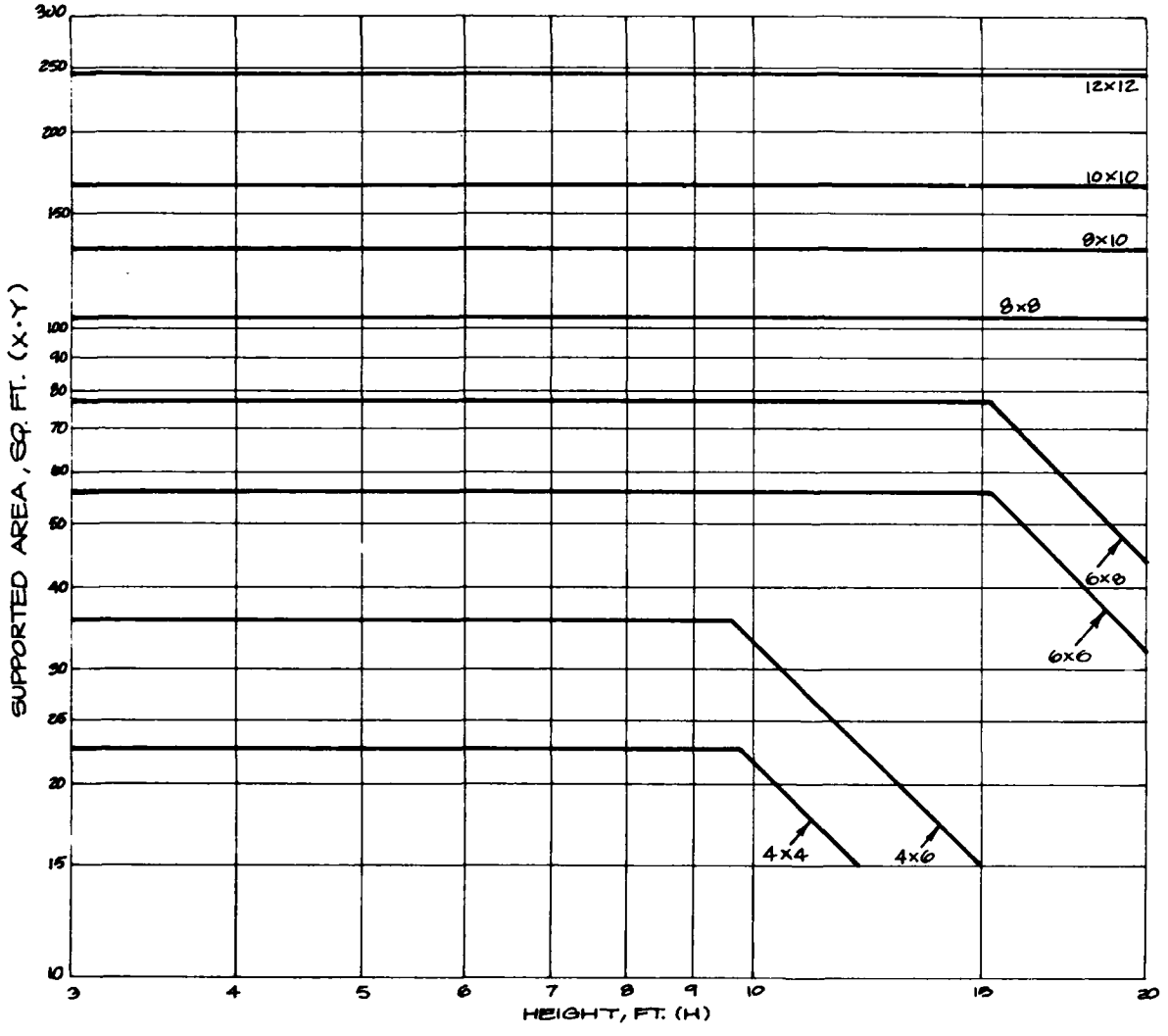
CHARTS

INDEX



STUD WALL DATA

A



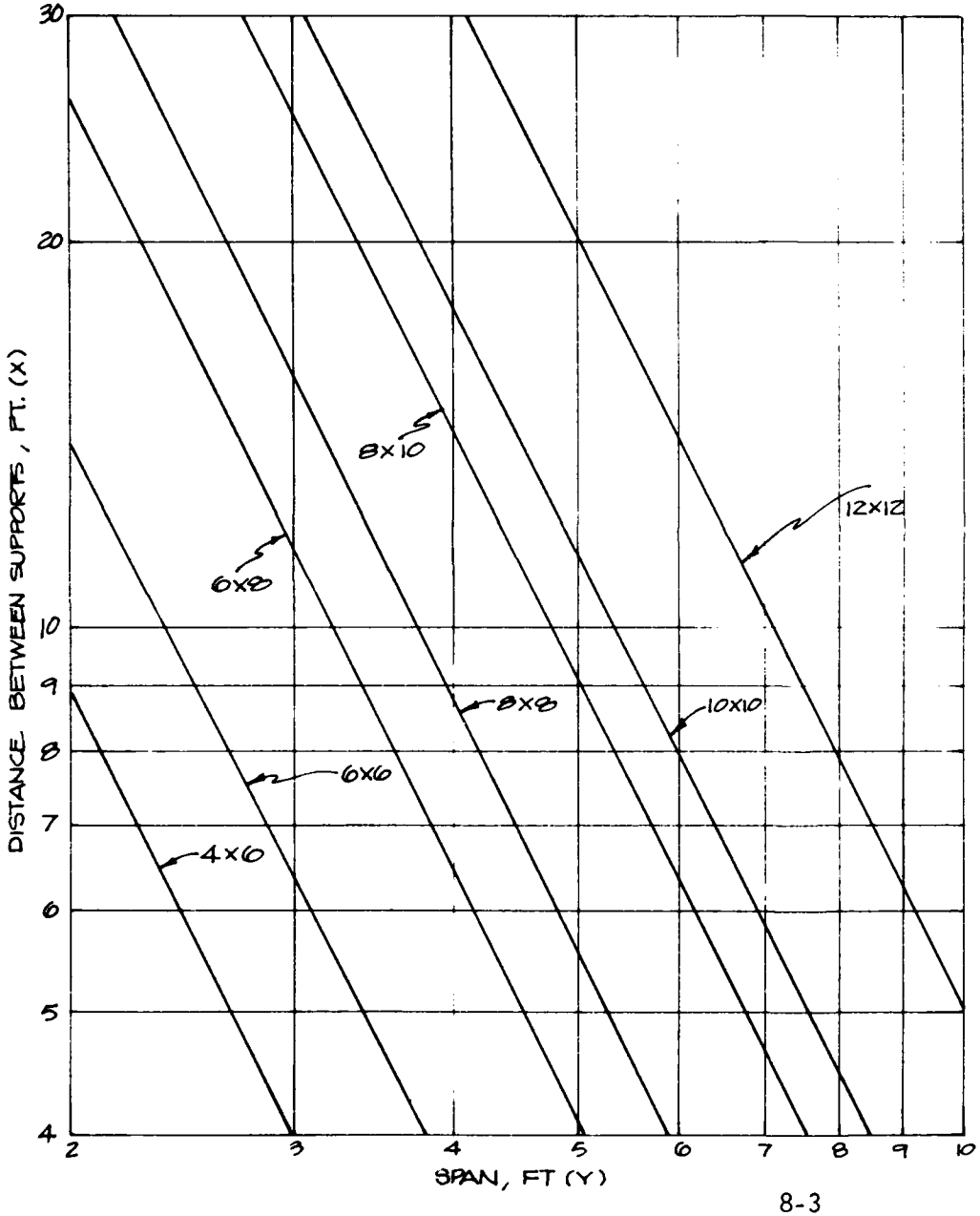
NOTE:

USE THIS CHART WHEN SUPPORTING TIMBER BEAM

TIMBER POST DATA

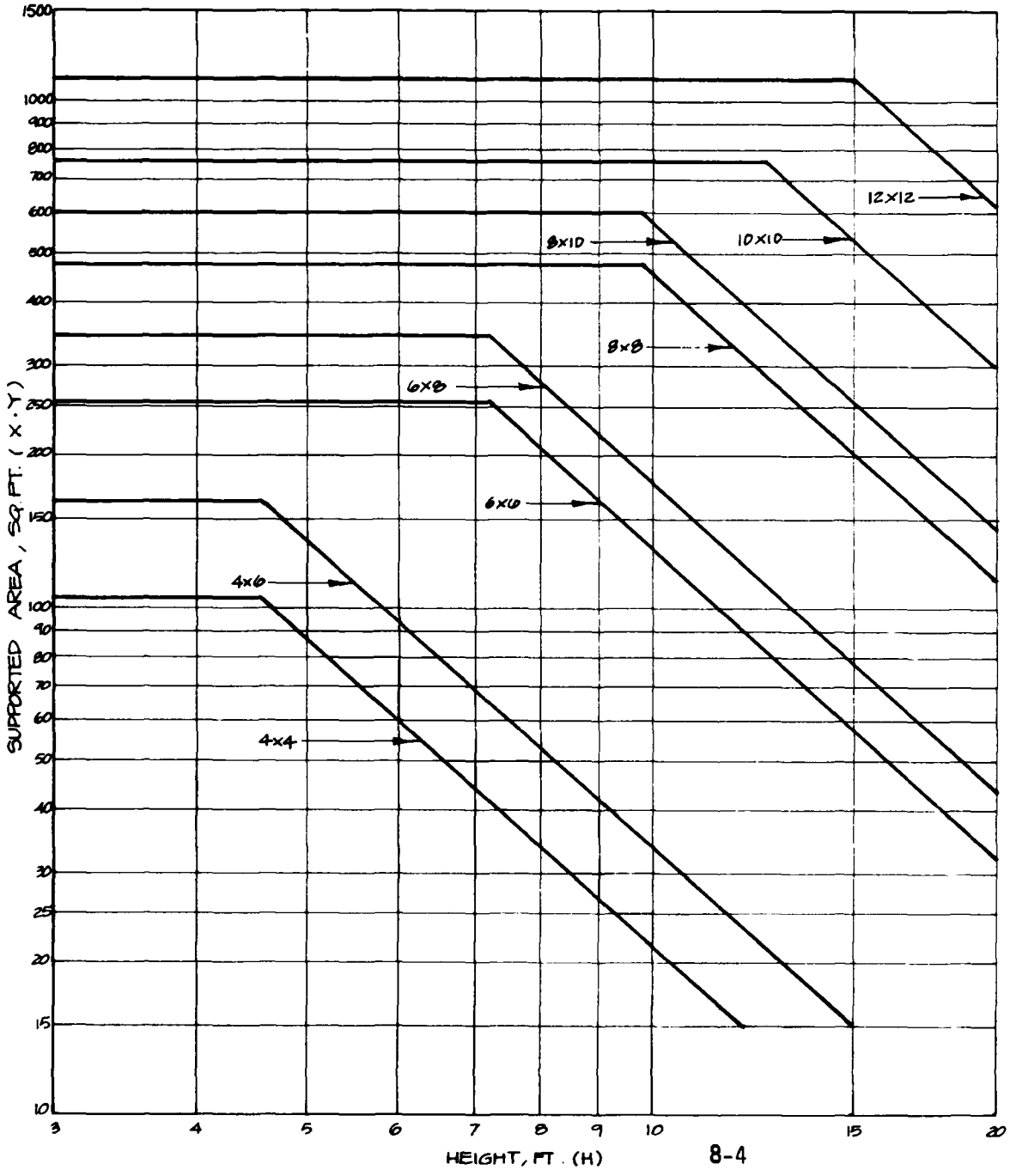
(WITH TIMBER BEAM DATA ONLY)

B



TIMBER BEAM DATA

C



NOTE :

USE THIS CHART WHEN SUPPORTING BEAM OTHER THAN TIMBER (STEEL, CONCRETE, ETC.)

TIMBER POST DATA

D

APPENDIX A

EVALUATION OF POTENTIAL SHELTER FACILITIES

Appendix A
EVALUATION OF POTENTIAL SHELTER FACILITIES

INTRODUCTION

Section 2 described a method for evaluating potential shelter facilities based on "intended use", or more specifically, the use for which the structure was initially designed. The objective of this section is to further assist in this evaluation by outlining some of the particular structural characteristics of building systems and materials that are important factors in arriving at a valid determination of the usefulness of the structure as a shelter.

INTENDED USE

Unfortunately, the "intended use" of a floor or roof is not always easily discernible, particularly in older buildings. Some residential homes (light) have been converted to restaurants (medium); warehouses (heavy) are now used as retail stores (medium); etc. Accordingly, it is important that "intended use" not be confused with "present use". The potential shelter facility may be better or worse than its "present use" indicates. Obviously, judgment on whether the system is light, medium or heavy should always be made on the conservative side if the facts on the building's history are not known or obtainable.

STRUCTURAL INTEGRITY

Once a potential shelter is selected, a reasonably thorough inspection should be conducted of the structural supporting members (deck/slab, beams, girders, columns, and walls). If the shelter is to perform up to the anticipated survival rating, it must not contain any major structural defects. All structures have built-in safety factors in both the materials and the expected loading. Accordingly, a structure may appear to be in fairly good shape and be serviceable, but, because of structural

defects, it may have lost the excess safety provided by these built-in factors. If this is the case, the use of this particular structure as a shelter would be questionable, and, at the very least, it should have a downgraded survival rating.

While it would be advantageous to have such an inspection conducted by individuals with expertise in building design, such as engineers or architects, this will seldom be possible. It is believed that an individual without such expertise, provided with some basic guidelines, small hand tools, and exercising reasonable judgment, can conduct an inspection that will be valuable in determining the structural integrity of a potential shelter. The following parts of this section outline, in a very basic way, the procedures for such an inspection, list the most likely areas for inspection, and assist in the evaluation of the structure for use as a shelter.

WOOD CONSTRUCTION

Light and medium floors would essentially be similar types of contruction — timber joists supported on either solid concrete or concrete block walls, or steel or timber beams supported by steel or timber columns. We will confine this discussion to all timber construction since steel construction will be considered later in this section.

Heavy timber construction would usually be found in older structures as it is not presently in common usage. It would most generally consist of heavy timber beams, girders, and columns supporting heavy plank deck and flooring. The column/girder and beam/girder connections are usually heavy cast iron or steel seats and/or brackets.

The principal problems to be considered in connection with timber structures are decay, insect attack, excessive deflection, checking, splitting due to shrinkage of the timbers in place, and deterioration of the connection hardware. These conditions can all be checked visually with the aid of a flashlight and an ice pick or knife. Decay, insect attack, and shrinkage splitting, unless extremely

excessive (25% of individual timber destroyed), would not be a determining factor in shelter evaluation. On the other hand, excessive deflection and deteriorated connection hardware are problems that could cause premature collapse during use as a shelter.

Joists or timber beams that are bowing downward in excess of ¼ in. per 3 ft of length are certainly not performing as designed, and downgrading of the shelter area should be considered if this condition is found.

Probably the most important areas to be considered for inspection are bearing and connections. The ends of the joists should be examined for adequate bearing (2 in. minimum). The timber beams should be bearing on the walls and/or columns a minimum of 3 in. The connections between the beams and columns should be secure and intact. The column should be plumb (vertical) and its base should be firmly attached to the floor with no evidence of excessive movement.

All of the above inspections may be conducted visually. Generally, what is looked for is any movement of the structure since construction. Movement of the structure, whether caused by foundation settlement, timber shrinkage, or other causes, can cause loss of bearing and connection distress. If such conditions are noted, downgrading of the shelter should be considered.

STEEL CONSTRUCTION

Light steel construction generally consists of steel bar joists (trusses) supporting metal deck or plywood topped with concrete fill or insulation board, supported on steel beams and/or concrete or block walls. The columns are usually steel pipe or tube.

Heavy steel construction consists of steel columns, girders and beams (usually I-shaped sections), and a supporting metal deck topped with structural concrete. The member connections are welded, riveted, or bolted.

Steel bar joists should be inspected thoroughly since the nature of their design requires proper initial installation as well as a future absence of even minor defects in order to assure satisfactory performance. An inspection of a bar joist floor or roof should begin with an overall look at the system. Are the bottom chords even and level with respect to each other, not one higher or lower than the other? The joists should all be in a vertical plane, not leaning to one side or the other. They should not be bowed horizontally. The joists should have lateral bridging, i.e., steel bars or angles located near the top and bottom of the joists, running perpendicular to and connecting the joists to each other by welding. The joists should have no sharp bends or "kinks" in them — such as could be caused by impact by a piece of equipment from below.

The second phase of the inspection should be done with a flashlight and scraper or screwdriver. Each end of each joist should be checked to assure that it is securely connected to the walls or beams. This connection should be accomplished with welds or embedded bolts (embedded in the concrete wall) welded to the joists. The webs (the diagonals running between the top and bottom chords) should be welded at each point of contact to the chords. It may be necessary to chip or scrape away dirt or corrosion in order to be able to observe these conditions. If only several welds are broken, or one joist appears bowed or deflected, it may be possible to make expedient repairs by rewelding or by double shoring the defective joist. If the defects are prevalent, downgrading the shelter area should be considered.

The primary deterioration of heavy steel structures is caused by corrosion, loosening of connections, foundation settlement, fatigue, and impact. Again, a cursory inspection looking for very badly deflected, bowed, or bent beams, girders, or columns would be in order. A closer examination with a flashlight and a scraper may reveal fatigue cracks or waviness in the flanges or webs. Corroded areas should be scraped to determine how deep the corrosion has penetrated. A hammer should be used if necessary, to remove loose material and assure penetration to "good" steel. Corrosion has been known to completely deteriorate quite large steel members. If the corrosion is not excessive (over 25% of the original thickness) nor widespread (over 10% of the total structure), and if the cracks found are "hairline" in width, short

and only several per member, the structure could be used as a potential shelter.

The final, and most critical, inspection is that of the connections. It should be determined that the welds, if any, are not cracked or corroded through. If bolts or rivets are present, they should be in place, not loose and not exhibit severe corrosion. Gusset plates and beam seats should be intact, not twisted, and secure to each member they are intended to hold together. The column should be plumb and connected top and bottom.

Obviously, one or two bolts missing or light corrosion is acceptable. However, it should be mentioned that only one severely deteriorated connection in this type of structure could cause collapse when used as a shelter.

CONCRETE CONSTRUCTION

Concrete construction is one of the more difficult types of construction to inspect visually since one of the primary structural components, the reinforcing steel or strands, is completely hidden from view. Conversely, if severe structural problems do exist, they are usually readily apparent to the observer.

Three basic visual symptoms of distress in concrete structures should be investigated: cracking, spalling, and disintegration. Although all of these conditions, particularly in their later stages, are unsightly, they are not necessarily structurally significant, and many times can be neglected in the evaluation for shelter use.

In general, cracking in concrete is an inherent characteristic of the material. Hairline cracks caused by shrinkage, and surface craze-cracking, usually caused during the finishing operations, are of no structural concern.

Spalling and deterioration, unless reducing the section (size) of the beam or slab by more than 10%, with the exceptions mentioned later, would not be reason for downgrading the shelter. This would be true even if this condition exposed the reinforcing steel or prestressing strand to some degree. The steel should, however, then be checked for corrosion. A good tool for determining extent of deterioration is a hammer. Sound concrete has quite a different "ring" to it than does deteriorated concrete, when lightly tapped with a hammer.

Conditions that should be checked, and if found to exist would be a basis for considering downgrading the shelter, are as follows: Cracks in slab floors (flat slabs, flat plates, and waffle slabs) 1/8 in. or wider around the periphery of the column or drop panel location; vertical or diagonal cracks, 1/8 in. or wider, at or near the supports of the beams, double or single stemmed units and prestressed slabs; excessive deflection in any member or slab (over ¼ in. per 3 ft of length); cracks in bottom of slabs or members near midspan greater than ¼ in. wide and extending up into the member more than 60% of its overall depth; and bearing less than 2 in. at the ends of precast members.

Although it is not possible to do expedient repair on cracks in concrete — this should be done by experts — some of the above problems can be negated by use of additional shoring under those members adjacent to the distressed areas.

WALLS

Walls will generally be poured-in-place concrete, precast concrete panels, or concrete block. Inspection of walls should be conducted with a flashlight and a light hammer.

Poured-in-place and concrete block walls are usually 8 to 12 in. thick and are solid concrete or individual hollow-core concrete blocks, with or without the cores filled with grout, mortared in place. These wall types should be checked for severe cracking and vertical and horizontal displacement. Most walls will have inherent cracking, and cracks up to 1/8 in. wide are acceptable provided the displacement

is minimal. If the wall is 8 ft high, it should not be leaning in or out more than a maximum of 1 in.

Precast concrete panels are usually installed as individual panels 8 to 12 ft wide and welded together at each joint. Again, the panels should be checked for severe cracking and displacement. An attempt should be made, if possible, to locate the welds and make sure that they are intact. However, this can sometimes prove difficult. If the panels are true and flush with each other and there has been no vertical displacement, the welds could be considered secure. Again, they should not be out of vertical alignment more than 1 in. in 8 ft.

SUMMATION

Much information may be obtained about the structural integrity of a potential shelter with the use of small tools, by picking, scraping,and rubbing. However, nothing is more valuable in making an evaluation than observation. It must be assumed, for our purposes, that the original design and construction was proper and within the accepted code limits. Accordingly, what you are attempting to ascertain is whether, during the life of the structure, changes have occurred which have altered its structural usefulness as a potential shelter. Observe the cracks: Are they "new" cracks, is the wood fresh and new looking inside the crack, is the exposed steel in a crack bright and shiny? These observations may indicate whether the apparent distress is dormant or active, and if active, a cause for concern.

If the beams have shifted on their supports, you should be able to observe their original location, and estimate the degree of displacement.

Observation should be made of rivets or bolts out of line and twisted or bent bolts and nails, all indicating movement of the structure. Again, if the structure has apparently performed adequately for a considerable length of time since the movement occurred, downgrading may not be necessary.

In addition, observations should be made, and consideration taken, of all structural modifications that appear to have been made after the original structure was completed: doors or windows sawed or cut through walls; ducts, pipes, or wiring passing through holes cut in joists or beams; added flooring of concrete or bricks; or heavy walls of brick or block added on the floor above. Some of these conditions may not have been contemplated in the original design, and accordingly, the structure may require downgrading.

APPENDIX B

CLOSURES

Appendix B
CLOSURES

It is probable that the majority of shelter spaces will need some form of closure. For example, a basement that has had the floor upgraded will probably have a stairway, windows, doors, ventilation ducts, access openings, etc. This section of the manual describes several methods of closing off such typical openings in the walls or ceilings.

Openings can be bridged by use of a number of readily available materials, such as wood, steel, or concrete. Examples of wood that may be used are fence posts, cut-up power poles, railroad ties, solid doors, and standard beams and plank pieces. Examples of concrete are sidewalk slab sections and curb or gutter pieces; and of steel, plate would appear to be the most practical from a handling and placing standpoint, but steel rolled sections could also be used. Additional materials that may be used to close openings are bags or oil or paper drums filled with sand or earth, broken concrete, bricks, or concrete blocks. Table B-1 contains a list of some of the materials that might be considered for use in closing openings.

With the wood and concrete categories there are material differences, which affect their strength. Wood fence posts, power poles, or railroad ties could be badly splintered or rotted in the center. Wood beams and planks could also be badly splintered. Generally, "poor" timber is "utility" grade when new, as well as older material that now has loose knots, or holes where the knots have fallen out. Poor timber may also have many checks, shakes, and splits. These features are illustrated in Fig. B-1. The concrete sidewalk slab and curb sections usually contain minimum or no reinforcing. These sections should be inspected for any significant cracking, which could impair their intended use.

Table B-1

CLOSURE MATERIALS

Steel doors

Wood doors (solid)

Toilet doors and partitions

Tree trunks and limbs

Steel cover plates

Desk and table tops

Railroad ties

Plywood

Concrete slabs (sidewalks, etc.)

Wood, steel, or concrete fence posts

Telephone or power poles

* Filled sandbags

* Filled paper bags

* Filled paper boxes

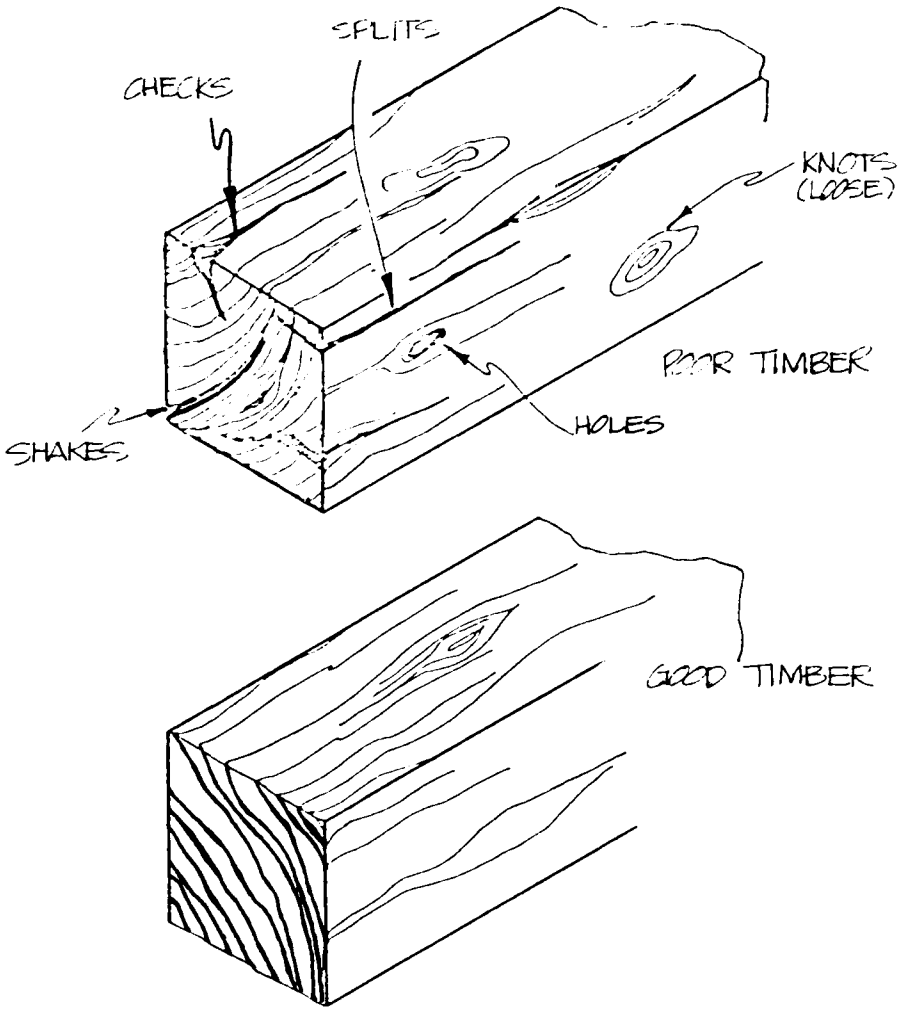
* Filled plastic garbage cans

Brick or concrete block

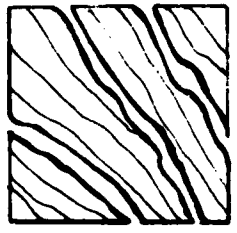
* Filled oil or paper drums

Broken concrete

*filled with sand or earth



ROTTED TIES OR POSTS



SPLINTERED POSTS / POLES / TIES

Fig. B-1. Factors Affecting Wood Strength.

The chart shown in Fig. B-2 indicates the maximum opening width that may be spanned without intermediate support for various materials. This chart can be used in several ways; (1) Enter the chart with the minimum opening width and list the type and thicknesses of the materials that would be required; a survey of the available resources could then be made in order to narrow the list to those most available or obtainable. (2) Enter the chart with a known available resource and determine the width of closure that this material will accommodate; this procedure will indicate if a further search for other resources will be required.

Example 1 — Assume there are two openings: one, 18 in. in diameter and one, 48 in. by 54 in. The shortest dimensions are 18 in. and 48 in., respectively. Entering the chart from the left with these dimensions (see Fig. B-3) yields the following list of materials:

18-in. Diameter	48 in. x 54 in.
1-in. wood post	3-in. wood post
1/8-in. steel plate	3/8-in. steel plate
1-in. timber (good or poor)	2-in. timber (good)
2-in. concrete sidewalk slab	3-in. timber (poor)
4-in. concrete curb/gutter	6-in. concrete sidewalk slab
	8-in. concrete curb/gutter

With these lists, check available resources.

Example 2 — Assume that you have a large quantity of 2-in.-thick wood fence material, which you consider to be in "poor" condition (see Fig. B-1). Entering the chart from the bottom at 2-inch Poor Timber shows that the maximum opening that can be closed with this material is approximately 36 inches. If you have openings larger than that, proceed as in Example 1 for these larger openings, and develop a list of required resources.

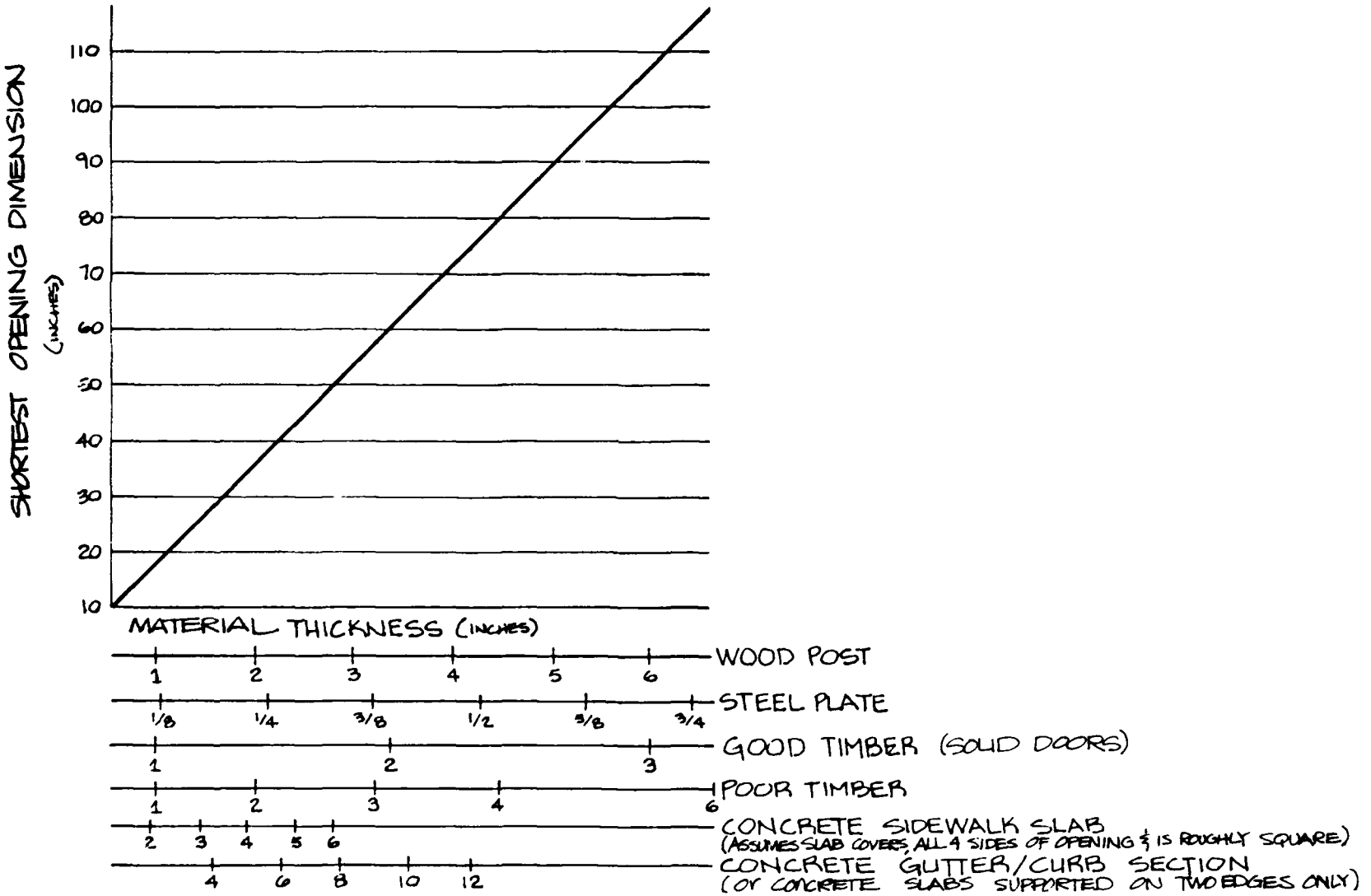


Fig. B-2. Material Thicknesses Required to Close Various Openings.

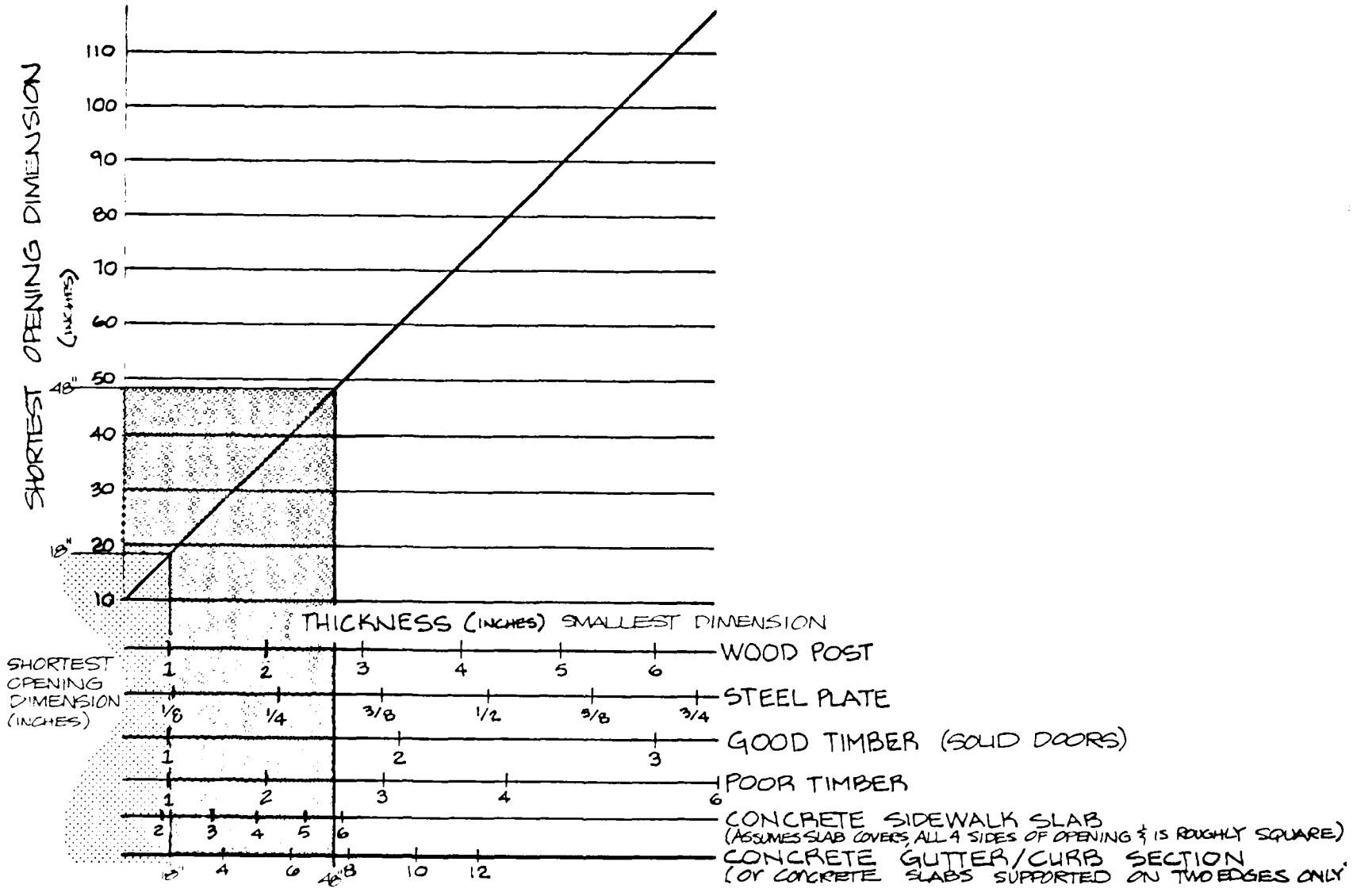
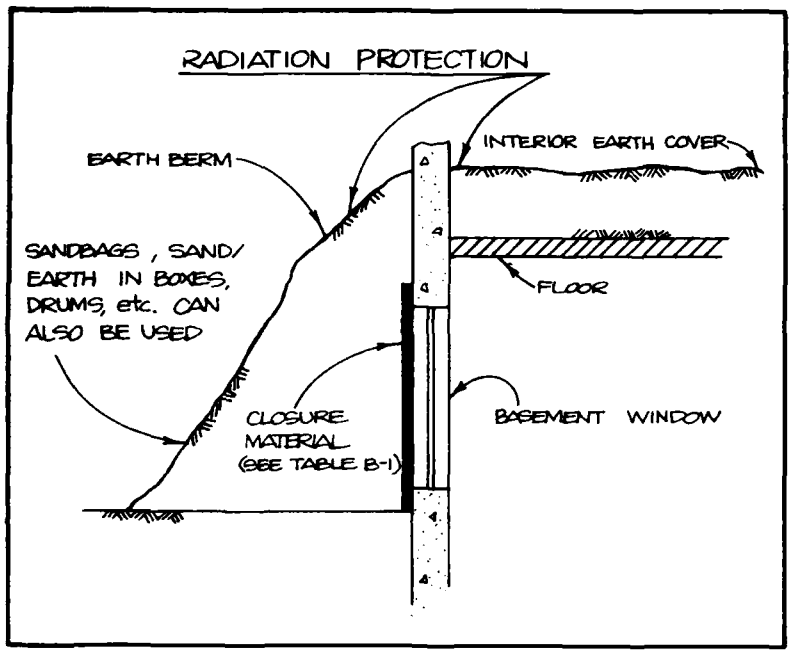


Fig. B-3. Material Thickness Chart as used in Example No. 1.

It should be remembered that the closed openings also require radiation protection. The chart on page 2-2, Section 2, indicates that the thicknesses of materials required to achieve various protection factors (P_f). One straightforward method is, of course, placing earth over the closed opening if it is horizontal, or piling earth against the closure if it is vertical. This, however, might prove to be difficult without a large number of personnel or earth-moving equipment, particularly over a basement floor enclosed by a structure on all sides. One expedient method of accomplishing this task is to place the earth (or sand or gravel) in containers such as sandbags, paper bags, cardboard boxes, plastic garbage cans, or oil or cardboard drums.

Figs. B-4, B-5, and B-6 show examples of suggested methods for closing several types of openings.



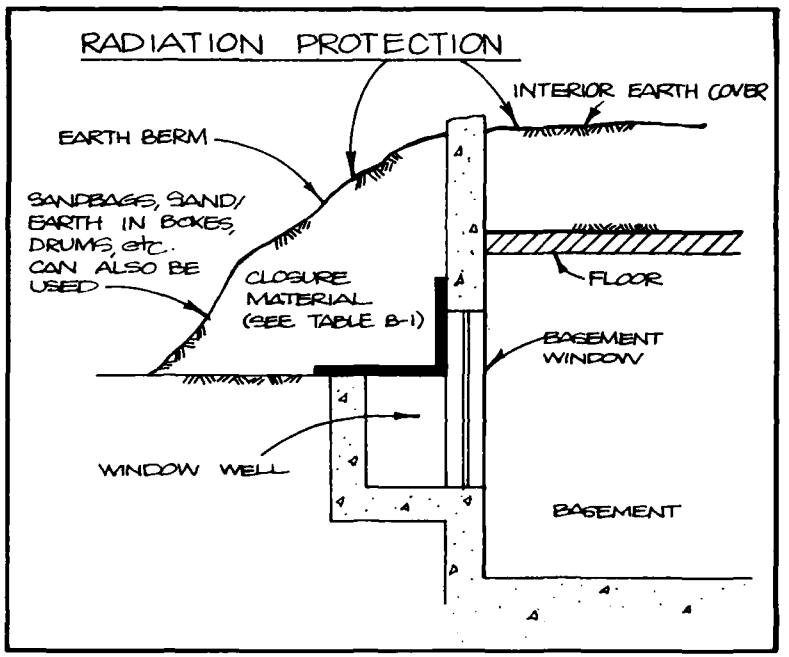
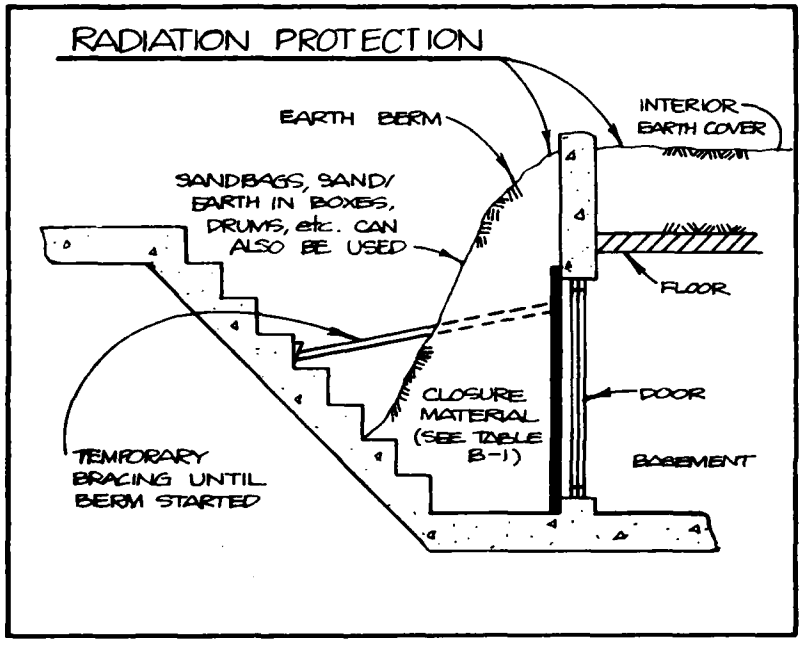


Fig. B-4. Window Closures.



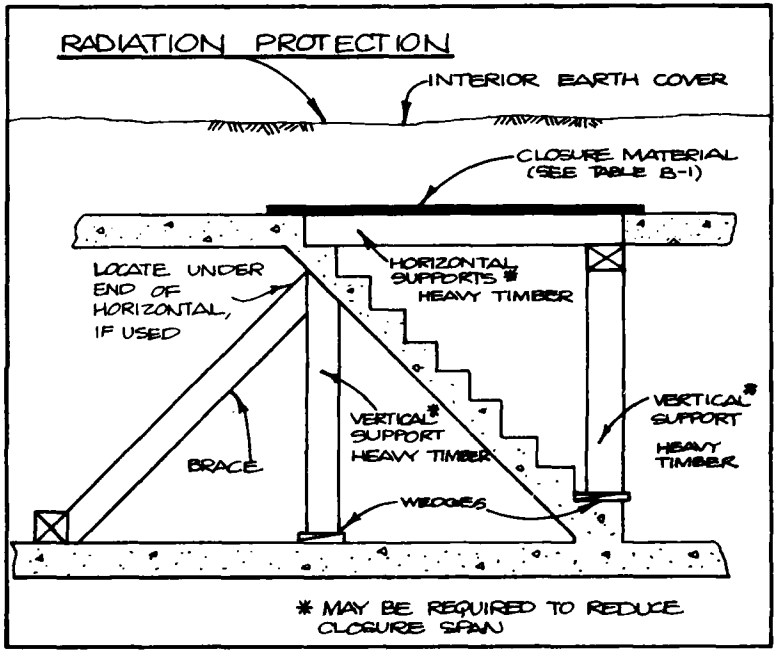
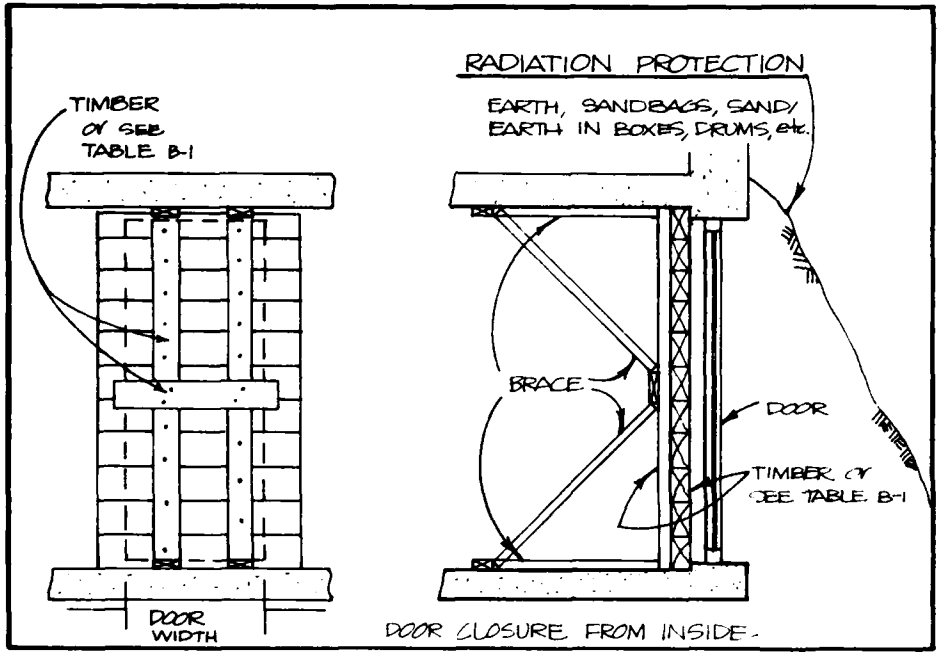


Fig. B-5. Stair and Door Closures.



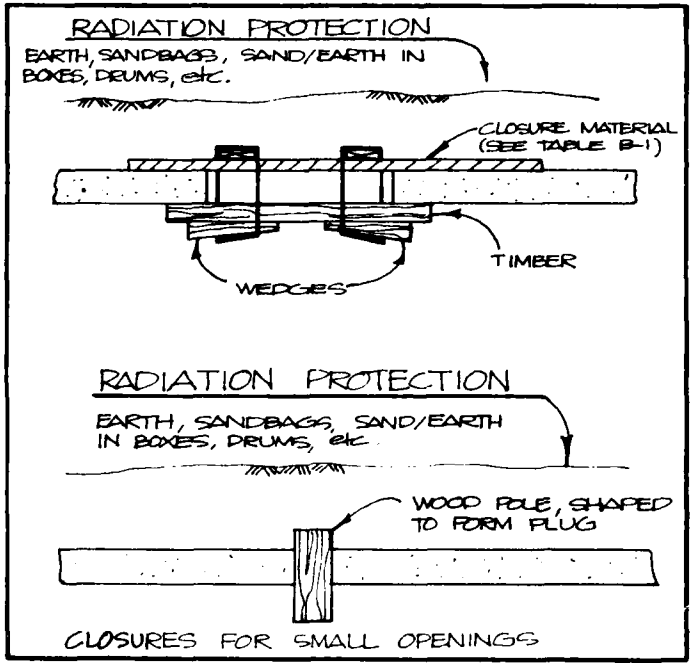


Fig. B-6. Door and Small Opening Closures.

APPENDIX C

ALTERNATIVE SHORING SYSTEMS

Appendix C
ALTERNATIVE SHORING SYSTEMS

In addition to the materials previously described and illustrated, there are other shoring materials that may be locally available and equally useful. Some construction projects or contracting yards may have shores or scaffold frames on hand. Shores are single post supports, while scaffolds are metal frames, each looking like an inverted "U" with cross bars. Shores can be either metal or wood. These types of shores are very useful in that they are generally designed for fast removal and erection and are adjustable to a variety of lengths. In addition to these commercial shores, there exist other available materials that may be utilized. Telephone posts cut to length, railroad ties, tree trunks and large limbs, and wood fence posts are examples. Steel pipe, steel fence posts, and structural steel sections (I-beams, channels, angles, tubes, etc.) may also be utilized. Table C-1 lists the relative strengths of some of these examples as compared to the dimensional timber posts of Charts B and D, pages 8-2 and 8-4, Section 8, for a fixed shoring height of 8 ft.

Important points to remember in setting any type of shore are that, if the shore is being used in a vertical position, set it as vertical as possible as observed from two different directions, and center the shore directly under the beam that is being supported. Also, always clear an area where the shore stands. Any type of wood or trash, etc., on a concrete floor, for example, may cause the shore to slide. When these shores rest on the ground, there should be a piece of plywood or lumber between the bottom and the ground to spread the load. Scaffold frames are limited to locations where they can be hauled in and set up without clearance problems.

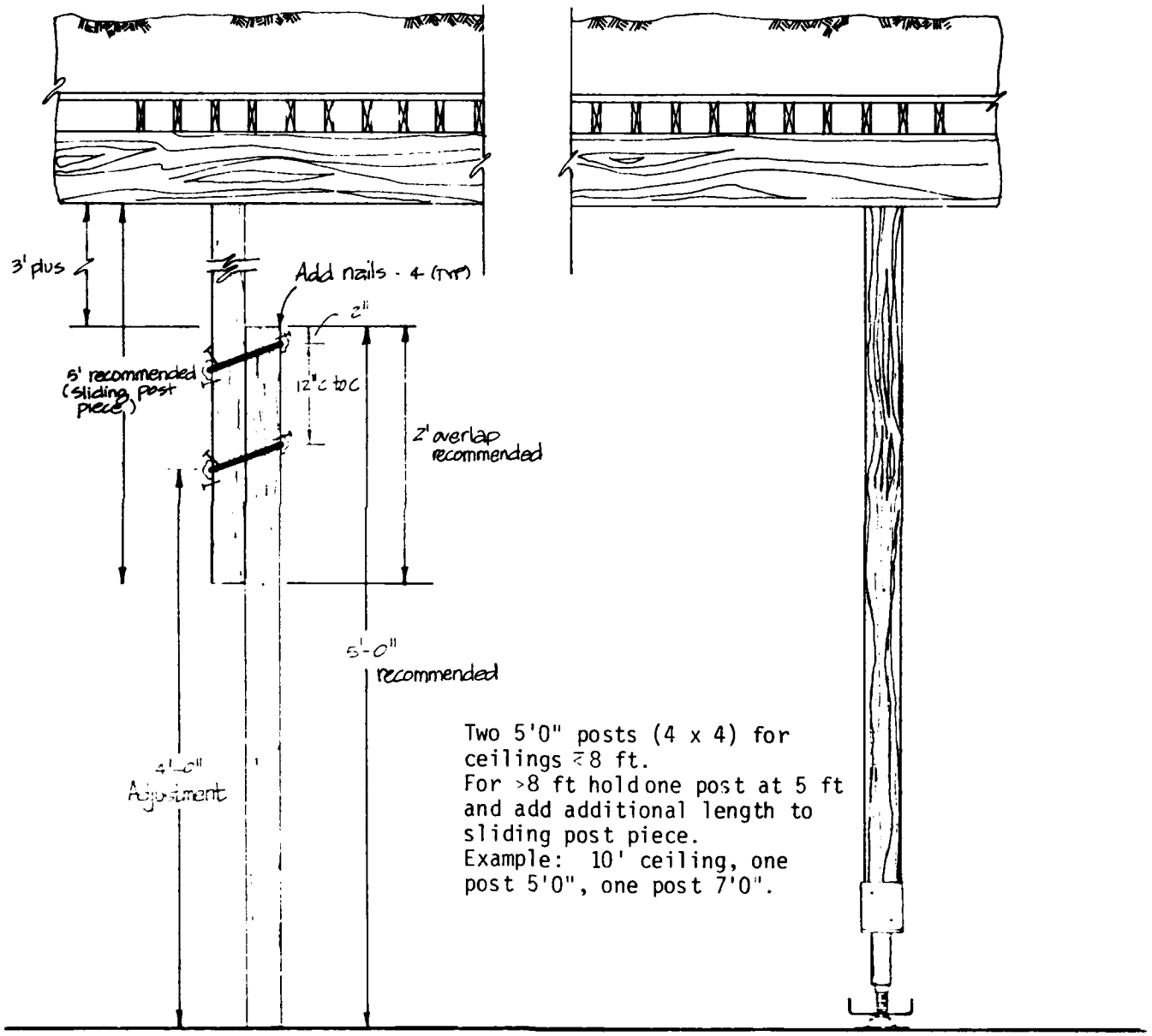
Several types of shoring are illustrated in Figs. C-1 and C-2; the sequence for setting the wood post shore is shown in Fig. C-3; and suggested applications of both shores and scaffolding are shown in Fig. C-4.

Table C-1

EXAMPLES OF MINIMUM SIZES OF ALTERNATIVE TYPES OF SHORES, 8 FT HIGH, AND THEIR RELATIONSHIP TO TIMBER POST CHARTS IN SECTION 8

Type of Alternative Shore	Minimum Size	Equivalent on Charts B & D	Remarks
Commercial Shores			
Wood or steel*	—	4" x 4"	Wood or steel posts, scaffolds
Wood			
Telephone post	10" dia.	8" x 10"	Good condition
Railroad tie	7" x 7"	6" x 8"	Good condition
Tree trunks or limbs	5" dia.	4" x 4"	Straight section
Fence post	4" x 4"	4" x 4"	Good condition
Structural Steel*			
Standard pipe	3½" dia.	4" x 4"	¼-in. thick wall
I-beams	S 6 x 17.25	4" x 4"	6" deep, 3-3/8" wide
Square tubes	TS 4 x 4 x .25	4" x 4"	
Rectangular tubes	TS 5 x 3 x .25	4" x 4"	
Angles, equal legs	L 5 x 5-5/16	4" x 4"	
Angles, unequal legs	L 6 x 4 x ¼	4" x 4"	
Channels	C 15 x 33.9	4" x 4"	

* When supporting timber beam with steel shore, plates should be used between top of shore and beam to distribute loads.



All wood post shore capable of adjusting to a great variety of heights.

Wood post shore with metal base adjustment, which can be adjusted only a small amount.

Fig. C-1.

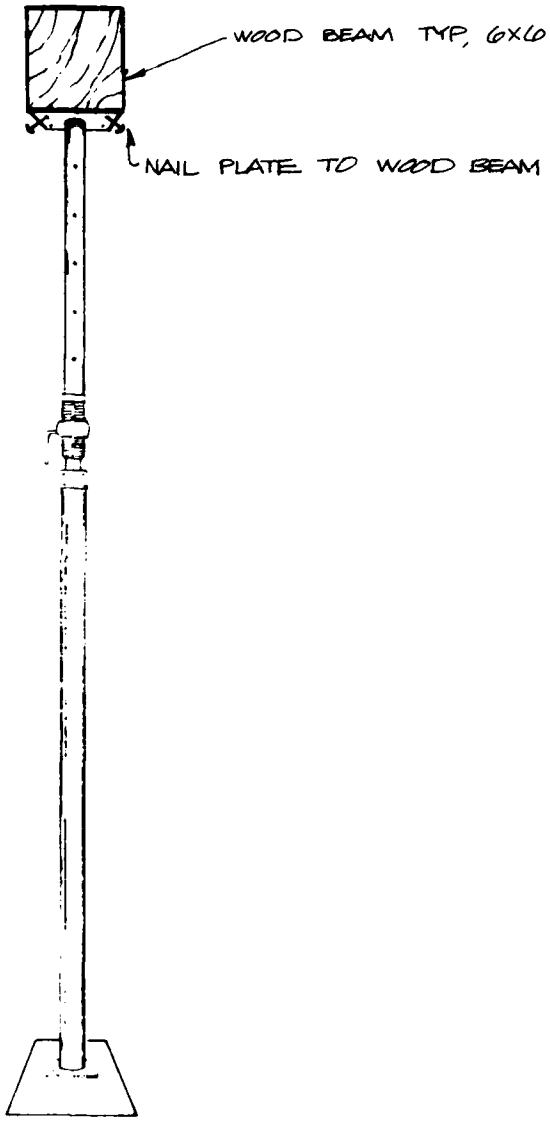
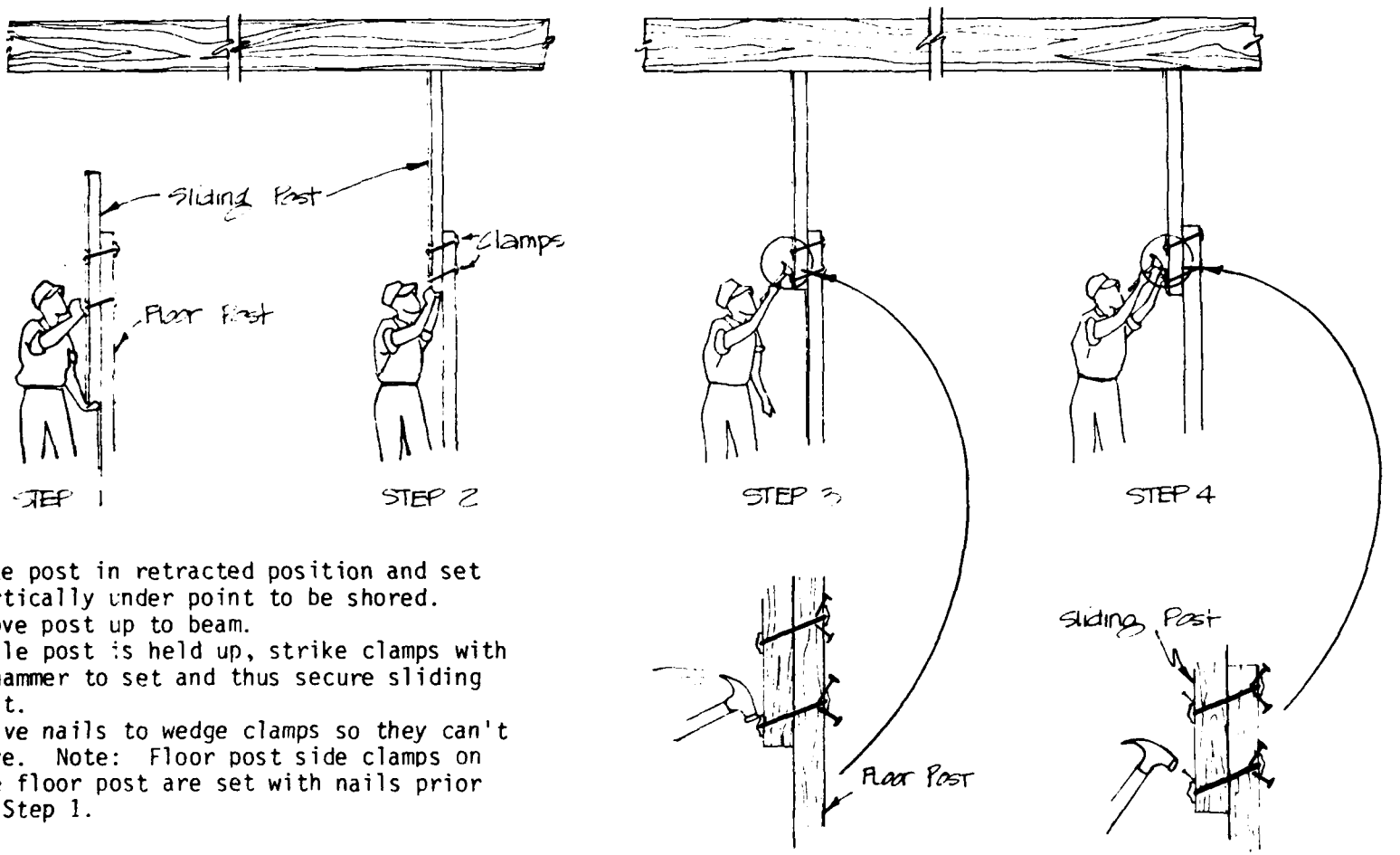


Fig. C-2. Steel Shoring.



1) Take post in retracted position and set vertically under point to be shored.
2) Shove post up to beam.
3) While post is held up, strike clamps with a hammer to set and thus secure sliding post.
4) Drive nails to wedge clamps so they can't move. Note: Floor post side clamps on the floor post are set with nails prior to Step 1.

Fig. C-3 Sequence for Setting All Wood Post Shore.

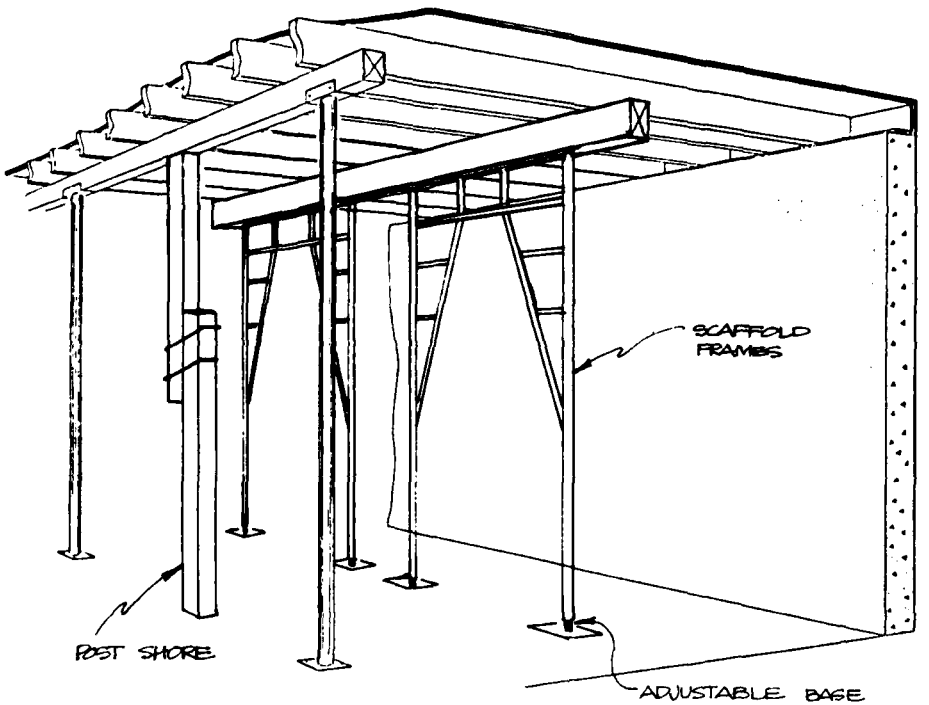


Fig. C-4. Applications of Wood Post Shores and Scaffolds.

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Scientific Service, Inc. Redwood City, CA, March 1980, 221 pages
Contract No. DCPA01-78-C-0215, Work Unit 1127H

This manual is one of a series being developed in support of the civil defense concept of crisis relocation planning. One basic element of crisis relocation is shelter protection of the people in the relocated environment, and without adequate shelter, crisis relocation planning is not viable.

This manual is designed to be used by planners in host areas. It presents a methodology for evaluating floors, roofs, and openings; develops a variety of ways to provide the necessary structural upgrading for blast and fallout protection; develops a framework for the practical use of the manual by all persons of interest; and contains charts, pictorial representations, and worksheets that complement and simplify the utility of the manual. The information contained herein is supported by a test program, DCPA01-79-C-0231, Work Unit 1127G, and previously developed structural information.

The manual is in looseleaf format to permit removal of pertinent worksheets and charts for developing upgrading plans for a specific building, and to permit the addition of new and replacement materials as the work progresses.

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